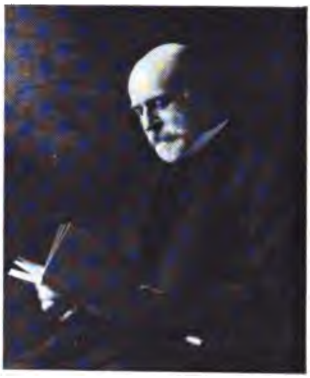

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DIRECTIONS TO THE BINDER.

JOURNAL

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GEOLOGICAL SOCIETY OF DUBLIN.

I.—Notes on the Geology of the East Coast of China. By Thomas W. Kingsmill, B.A.

[Read April 2, 1862.]

Hong Kong, January 13, 1862.

As I am sure that a slight sketch of the geology of an interesting and comparatively unexplored country, like China, will not be unacceptable to the members of the "Geological Society of Dublin," I have endeavoured to throw together a few remarks on the subject, partly from personal observation, and partly from the scanty notes I have been able to glean in various quarters. Many portions have been illustrated better and more fully before, but I have not been able to obtain access to any of these notices, and have had to rely on what means of information respecting the later deposits chance has thrown in my way—my own observations having as yet been confined to the neighbourhood of Hong Kong, the Canton River, and the district immediately about Foochow, with a passing glance at the intermediate coast.

Commencing with the igneous rocks, there stretches from the neighbourhood of the island of Hainan, in a N.N.E. direction, as far as the Chusan Archipelago, a range of low granite mountains, varying in height from a few hundred to perhaps three thousand feet, and averaging in breadth from twelve to thirty miles. These hills form, in most of the intermediate districts, the coast line; seldom receding more than a few miles inland, and only flanked at intervals, next the sea, by patches of a later formation. Commencing at Canton, and running parallel to these, there is another range of similar hills, but for what distance these extend I cannot now tell. From the maps they would

appear to join the Me-ling-shan or Plum mountains, another range running east and west, north of the province of Canton, and which likewise are described as composed of granite. The rock of which these ranges are composed appears throughout to be of similar structure and composition. The chain running along the coast is at all events similar, at its extremities, and wherever I have seen it in the intermediate portions. If I mistake not, some specimens from Hong Kong have been analyzed by the Rev. Professor Haughton, who has pronounced them to be very similar to the same rock from the county Dublin—to which in appearance, when undecomposed, it bears a striking resemblance.

This granite, wherever it occurs, has been deeply disintegrated, sometimes to a depth of one or two hundred feet; whilst everywhere, imbedded in the soft yielding matrix, there occur nodules of more quartzose character, which have resisted the effects of time and chemical change. These masses are usually of a lozenge shape, and vary in size from a few feet to several hundred. The original quartz veins of the granite, broken into small fragments by the forces which have operated on the surrounding rock, still traverse the disintegrated mass in all directions; whilst round the enclosed nodules the concentric structure of the rock can generally be traced. In the higher grounds the soft yielding matrix has generally been removed by denudation, leaving these pseudo-boulders perched all over the granite hills, presenting an aspect, to a passing eye, not unlike the boulder formations of more northern latitudes. I have been particular in describing the character of these, as they produce a marked feature in the scenery of the granite districts, and have led to erroneous ideas on the southern limit of the glacial drift, which, in Professor Ansted's "Elementary Treatise," is described as reaching as far as Macao.

This same disintegrated rock, too hard for the roots of plants to penetrate, and yet yielding enough to allow its surface to be continually washed away by the heavy rains of summer, causes the coast of South China to present a peculiarly barren and uninviting aspect, sadly belying the fertility of the great plains of the interior. Long lines of bare white sand, with scanty herbage between, stretch down from the mountain summits to the water's edge; these masses of sand are intersected in all directions by deep narrow ravines, worn by the tropical rains, which wash down their sides frequently with sufficient force to bear down large masses of rock, and which render walking through these districts unpleasant and dangerous.

In the province of Quan-si, west of Canton, a gneissose rock is described as occurring, of which more anon. I find the ranges of this district described as running in a direction nearly east and west, a direction also taken by the Me-ling range, and some of the chains in the extreme north. This appears also to be the direction of the gaps in the coast line through which the rivers in the southern provinces find their way to the sea.

Resting immediately on the granite occurs a stratified formation,

most likely of early Silurian date. It may be seen to advantage in the island of Hong Kong, though it appears to occur along the flanks of the granite for its whole extent; in a few spots being found at the sea, as well as on the land side. It is to be seen on the Canton River, below Whampoa; in the neighbourhood of Amoy; at Foo-chow; on the Yang-tze-Kiang; at Chi-Kiang, below Nan-King; and in the island of Hong Kong, preserving all through the same general character. A rock has likewise been described in the flanks of the Me-ling mountains, of apparently similar character. In Hong Kong a strip about two miles wide, entangled in the granite, runs across the island from W.N.W. to E.S.E. It is composed of masses of quartz rock, traversed by cleavage planes in all directions, alternating with beds of slate and quartz, plainly stratified. The strike of the beds generally appears to approach east and west—the inclination of the beds being high, about 80° at Hong Kong and Foo-chow; however, it is generally difficult to distinguish the bedding from the cleavage. At Aberdeen, at the south side of the island, immediately behind Lamont's graving dock, I found a few fossil shells, apparently of the one species, imbedded in very soft slate; they were badly preserved, and too soft to bear carriage.

In some places this rock might be mistaken for an igneous formation, and in others it approaches conglomerate, containing small crystals of quartz, slightly water-worn. The colour is generally a light yellowish-brown, but runs into a blueish stone, and in some places becomes black. Although the general aspect is similar through large districts, it would be difficult to obtain two specimens alike, even from the same neighbourhood.

Over this is found a red sandstone formation, but whether conformable to it or not I am unable to state, as I have nowhere seen their junction. From the usual strike of the formations, I should judge not, as the strikes of the two formations apparently cross at nearly right angles. The composition of this red sandstone does not appear to offer any peculiarities of structure or composition. In some parts it runs into conglomerate, whilst in others it forms an even-grained stone. It is to be found at Canton; at the Bogue Forts, in the Canton River; in the West River, above Shai-Heng; and along the North River nearly to the base of the Me-ling range. It is also to be found at the city of Nan-King, and most likely stretches through the intermediate country along the flanks of the Broken Hills. So far as at present known, it is, I believe, unfossiliferous.

At the entrance to the West River (See-Kiang), there occurs a dark fine-grained aluminous schist, much used for ink-stones, and fine carved work. Of its geological position I have no data for speaking. It occurs geographically between the red sandstone and the limestone, hereafter described. It appears, however, to extend for a very small distance, and, being rather valuable, is jealously guarded by the neighbouring mandarins.

Over the red sandstone, and, I believe, lying conformably on it, is found the great limestone formation of China,—the representative, most

probably, of the carboniferous limestone of Europe. I have as yet seen none of it, nor of the higher formations, *in situ*, and can only speak from the accounts of others. In the district south of the Me-ling mountains, it is highly metamorphic, owing most likely to the presence of the igneous rocks of which I have already spoken. In the province of Quan-si, it appears tô be destitute of all fossils, the only organic trace consisting probably of veins of graphite, which appear in some parts of the formation to a large extent. Along the banks of the West River (See-Kiang), and North River (Pei-Kiang), this rock, rising in sharp-pointed pyramids, forms a conspicuous object in the landscape. The lower portion of the banks are composed of red sandstone or conglomerate, from which the limestone, here changed into crystalline marble, springs abruptly upwards in high cliffs, perforated with numerous caves, of which those in the neighbourhood of Shai-Heng on the West River are celebrated. These cliffs terminate in needle-like summits, rising to considerable height, whilst the country around is strewn over with sharp broken masses of the same rock, the edges of which are so acute as to render travelling by foot through these districts no easy task. At Shai-Heng, and along the banks of the West River, the marble varies in colour from a very light grey, almost white, to black. It is generally shaded by black zigzag lines, composed of graphite more or less pure. It is extensively used for flooring purposes, being cut into squares of about one foot each way, which are laid diagonally; the separate squares alternating in shade. The marbles from the other districts vary greatly in colour, from almost white, through green and red, to black; they are much used for table tops and other household purposes, and are sometimes very beautiful. North of the Me-ling range, this rock assumes a similar appearance to the corresponding rocks in Europe, and is apparently distinguished by much the same fossils. It is to be found in large masses along the Upper Yang-tze, and in the neighbourhood of Peking. Near Peking, at Lu-end-twang, occurs a blueish-yellow slate, of so fissile a character as to be used for covering houses. From its position geographically, it is not unlikely to belong to this formation or the base of the next.

Immediately succeeding the limestone, appear to come the coal-measures, the lowest member of which is apparently a micaceous sand stone, interstratified near Peking with a compact limestone and beds of iron-stone. The coal-beds there are spoken of as being overlaid by a bed of compact limestone, and appear to be of somewhat anthracitic character. At Neu-Chwang, a port lately opened at the head of the Gulf of Liotai, a branch of the Gulf of Peichili, the coal is spoken of as of a more bituminous character, and suitable for steam-engines. It approaches the sea here, but I know nothing of the mines. In the province of Sy-tchuen, and along the greater portion of the Upper Yang-tze, are enormous beds of coal of variable quality, still interstratified with, or resting on, the same micaceous sandstone. In the Bohea hills there is also a coal district, in which the accompanying sandstones are spoken of as containing sigillariæ and stigmariæ of

similar species to those found in Europe. In the province of Chi-Kiang, near the sea coast, a coal district also occurs—the coal-measures, probably, are continuous through much of the intermediate districts, cropping out along the synclinal and anticlinal folds of the strata, which through this portion of China appear to run from south to north a few points east. In this case the coal-fields of China may prove to be the largest in the world, and doubtless, at some future period, will have an important influence on the destinies of the East.

In the Peking coal district the mines are worked in a very peculiar manner (*vide* "North China Herald," Dec. 14, 1861), the shafts being sunk from the summits of a low range of hills in which the coal is found, in a spiral direction, at an angle of nearly 45°, up which the products are dragged in a rude kind of sledge by boys, with straps passing over their shoulder, and out between their legs. At the bottom, galleries branch out in various directions, with roofs supported by timber props. A primitive sort of ventilation is effected by timber doors placed at intervals across the passages, to deflect the currents of air. The coal is occasionally fiery, and explosions take place. Frequently the mines get flooded, in which cases they are abandoned, and new shafts sunk,—it never having occurred to the owners, that the latter might be obviated by driving adits from the sides of the hills to strike the beds. In the other districts coal-mining would appear to be almost confined to the outcrop of the seams, which in some measure may account for the present inferior quality of Chinese coal. It is, however, coming into use; much of the coal burnt in the steamers on the Yang-tze, and to the northern ports, being obtained from the Sy-tchuen or Neu-chwang fields, but as yet most is obtained from Japan, where the government hold a monopoly of the mines.

There do not, as far as I am aware, appear to be any formations of later date than the coal-measures, with the exception of the alluvial deposits of the great plains, and perhaps some secondary rocks in the island of Hainan. To what date the former deposits should be ascribed is very doubtful, but at the mouths of the great rivers they still appear to be in course of formation. These plains occupy the greater portion of China. They are everywhere intersected with canals and dykes, natural or artificial, and seldom rise to more than a few feet over the medium level. Along the great rivers they are periodically flooded. The Yang-tze, during the rainy seasons, inundates the lowlands on both sides to an enormous distance, completely depriving vessels navigating its waters of the ordinary landmarks. A large portion of the province of Sy-tchuen is yearly converted into a lake, a few feet deep. In fact, during the early portion of the summer, most of China is under water, being flooded by artificial means where the ground rises above the flood-level of the rivers; every valley between the mountains, no matter how small, is terraced, and the mountain streams made to do duty from their very rise. From the mouths of the Yang-tze to the walls of Peking, along the Grand Canal, there scarcely occurs a rising ground; the soil is so soft and muddy, that it has been found

next to impossible to form a carriage road in the British settlement at Shanghai. One may wander for days through these districts, and not find a single pebble. For the same reason, the towns in these districts are left unpaved; the streets, during the wet season, forming deep masses of soft oozy mud, rendered still worse from the total want of drainage.

In taking a general view of the geology of China, the country would appear to divide itself into two districts—one consisting of the provinces of Quan-tung, Quang-si, and the southern portions of Yunnan; the other, of the northern portions of Yunnan, and the other provinces lying northwards. They would seem to be divided by the range of mountains running from W. to E. through Yunnan, and terminating eastwards in the Me-ling range, across which the road from Canton to Hankow passes at a considerable elevation. South of this line, the rocks appear to have more of the metamorphic character, and to contain little, if any, coal; whilst to the north they are much less altered, and contain abundant stores of mineral fuel. To the south, the prevalent lines of elevation appear to have a tendency to east and west; whilst to the north they rather assume a north and south direction. These are, however, merely conjectures, to be verified or the contrary by future explorations; and now that China is at last becoming more open to foreigners, it is a subject that will no doubt receive proper development, especially as the question of a practicable overland route to India is just now receiving considerable attention, both here and at home. As this is not a subject coming directly under the notice of a Geological Society, I shall merely state that three ways have been proposed. The first, by the Yang-tze, through Thibet, has been attempted, and given up, I believe, from difficulties arising, not from the impracticability of the road, but rather from the formation of the party; the second is from Peking, through the northern provinces, and across a great part of Thibet; and a third, not improbably the most practicable, from Canton, up the West River, through Yunnan, to Moneypoor, from whence the remainder of the road to Calcutta is well known. The latter will, it is likely, be the more interesting in a geological point of view, as this part of the world has not as yet been explored by Europeans.

I have put together these few jottings from the experiences of a few months in one portion of the country; the greater portion have merely been picked up from the accounts of parties who had more or less experience of the objects of interest. Few of the members of these were geologists; and none of the expeditions, with the exception of that up the Yang-tze, have been conducted on scientific principles. To Captain Blackiston I am indebted for an examination of his geological specimens, collected during that journey; but a full description of these has doubtless appeared before this time. At some not distant period I hope to penetrate some of the more interesting districts, when I hope I shall be able to give a more accurate and detailed description of what I have seen, and possibly obtain a few of the more interesting fossils of the various formations.

II.—The Dhurmsalla Aërolith.

[Read March 12, 1862.]

The following account of this interesting aërolith was forwarded, with a specimen of the stone, to the Museum of Trinity College, Dublin :—

Copy of a Letter from the Deputy Commissioner, Dhurmsalla, to R. H. Davies, Esq., *Secretary to Government Punjab, No.* 927, *dated the* 30*th July*, 1860.

"I have the honour to submit for the information of the Honourable the Lieutenant-Governor a full account of Meteorolite that fell at Dhurmsalla on the 14th instant.

"2. In the afternoon between the hours of 2 and 2–30 p. m., the station of Dhurmsalla was startled by a terrific bursting noise, which was supposed at first to proceed from a succession of loud blastings, or from the explosion of a mine in the upper part of the station, others imagining it to be an earthquake or very large landslip, rushed from their houses in the firm belief that they must fall upon them.

"3. It soon became apparent that this was not the case. The first report, which was far louder in its discharge than any volley of artillery, was quickly followed by another and another to the number of 14 or 16, most of the latter reports grew gradually less and less loud. These were probably but the reverberations of the former, not among the hills but amongst the clouds, just as is the case with thunder. It was difficult to say which were the reports, and which the echoes. There could certainly not have been fewer than four or five actual reports. During the time that the sound lasted, the ground trembled and shook convulsively.

"4. From the different accounts of three distinct eye-witnesses, there appears to have been observed a flame of fire described as about two feet in depth, and nine feet in length, darting in an oblique direction above the station after the first explosion had taken place. The meteoric flash was said to be N. N. W., to S. S. E. Fragments of aërolite fell in the same direction at the following places:—

"In the ravine below the Dhurmsalla Kotwallee at the Village Sadeir.

"On the Barrack-hill, close to the Convalescent Depôt.

"At the River Guj, four miles from the Kotwallee.

"On the Parade-ground of the Sheredil Police Battalion, between the graveyard and the Native Distillery.

"In the village of Kerayree, on the hill to the right of the station looking towards the plains and at the Bowarna Thannah.*

"5. Specimens from each of the above localities have been brought into the station.

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* It must be noted that Kerayree, the Barrack-hill, the Kotwallee Kudd, the grave-yard, and Bowarna, are in one direct line from N. N. W. to S. S. E.

"6. It is said that meteoric stones fell likewise in the following places, but no specimens have been received from them:—At Kunhiya, near the slate quarries at Madhopore, and at Bissowlee on the Ravee, and in parts of Chumba and Rhilloo. I am making further inquiries with regard to these places.

"7. The stones as they fell buried themselves from a foot to a foot and a half in the ground, sending up a cloud of dust in all directions.

"8. Most providentially no loss of life or property has occurred.

"9. Some coolies passing close to where one fell, ran to the spot, to pick up the pieces. Before they had held them in their hands half a minute, they had to drop them, owing to the intensity of the cold, which quite benumbed their fingers.

"10. This, considering the fact that they were apparently, but a moment before, in a state of ignition, is very remarkable; each stone that fell bore unmistakeable marks of partial fusion.

"11. The morning and afternoon preceding the occurrence had been particularly dull and cloudy. The temperature was close, sultry, and oppressive. The thermometer was above 80 degrees of Fahrenheit, and no rain had fallen. I had no barometer by me at the time, I am therefore unable to state what was the precise pressure of the atmosphere. The clouds which were of the form technically called cumulus and cirrus were hanging low at the time, and the atmosphere was heavily charged with electricity.

"12. Such are simply the facts of the case as they occurred.

"13. There are of course all sorts of conjectures as to the probable cause of the occurrence—some state the stones to be of volcanic origin, others that they were hurled from the heights about the station, or projected from the Moon, but I am inclined to regard them as real *bonâ fide* meteorolites. Their weight seems to indicate that they are semi-metallic substances, composed probably of meteoric iron alloyed with nickel, and mixed with silica and magnesia, or some other earthy substance. They are nearly double the weight of a piece of ordinary stone of similar dimensions.

"14. Such a phenomenon is not without precedent. It is on record that in Siberia a mass of iron once fell weighing 1680 lbs., and in Brazil another weighing 14,000 lbs. In Peru a piece fell weighing 15 tons; and it is said that some knives of iron alloyed with nickel were found by Officers connected with the Arctic expedition among the Esquimaux in Greenland, which must have been made of metal taken from Meteoric masses, for these two metals are not found together as a mineral product anywhere.

"15. I have sent specimens of the aërolite to the Museums at Lahore and Umritsur, and to Scientific institutions in America. I am about also to send others to the Academy of Sciences in France, to the Asiatic Society in Calcutta, and to Monsr. H. Schlagintweit at Berlin in Prussia, for examination and report.

"16. One fact, if true, is curious, viz., that the report preceded the flash, instead of followed it; this I cannot at all account for.

"17. The common theory with regard to such phenomena is that they are fragments of some planetary body of our system which has been destroyed, and these portions, as projected into space, have accidentally come within the sphere of the earth's attraction, which extends to about forty-five miles above the surface, and consequently fallen on it. Some believe that the tail of a comet coming in contact with one of the minor planets, or asteroids, annihilates it instantaneously. Indeed, in England, when the comet which was predicted to appear next month was discussed, some said that if the length of the tail was to extend over half the area of the heavens, the safety of our own planet would be in jeopardy.

"18. I believe that I was the first at Dhurmsalla to discover the new comet now visible in the heavens. I saw it first on the evening of the 4th July, and I have met no one yet who will allow that there is a comet; subsequent accounts in the papers prove that I was correct.

"19. Another very singular phenomenon was witnessed at Dhurmsalla on the evening of the same day that the aërolite fell. This appears to have been a succession of igneous meteors, such as fire-balls, or falling and shooting-stars.

"This singular sight did not attract the attention of most people. I quote the account (from the writer who describes it) *verbatim*:—'I think it was on the evening of the same day that the meteor fell, that I observed lights in the air; they commenced to appear about 7, P.M., and lasted about three hours till 10. They appeared for about one minute, some for longer, then went out again; other lights appeared in the same place. Sometimes three or four lights appeared in the same place together, and one or two moved off, the others remaining stationary; they looked like fire-balloons, but appeared in places where it was impossible for there to have been any house, or any roads where people could have been; some were high up in the air, moving like fire-balloons, but the greater part of them were in the distance in the direction of the lower hills in front of my house, others were closer to the house, and between Sir Alexander Lawrence's and the barracks. I am sure, from some which I observed closely, that they were neither fire-balloons, lanterns, nor bonfires, or any other thing of that sort, but *bonâ fide* lights in the heavens. Though I made enquiries amongst the natives the next day, I have never been able to find out what they were, or the cause of their appearance.'

"20. Verily this has been an extraordinary season in more ways than one.

"21. In different newspapers I have read accounts of other very extraordinary phenomena, all occurring within the last few months; for instance, an aërial meteor or water-spout in the neighbourhood of Bhurtpore, where an aërolite is said also to have fallen. A luminous meteor, or something which, from the newspaper account, reads like an aurora borealis, at Delhi. This was on the night before the meteorolite. A shower of live fish at Benares, unaccompanied by rain. A similar shower,

but unaccompanied by rain, fell some years before at Agra. A shower of blood at Furruckabad, and likewise at Meerut previously.

"Also a dark spot observable on the disc of the sun.

"22. Besides the recent shock of an earthquake slightly felt here, there was an unnatural yellow darkness of some duration, followed by a violent wind-storm from 3 P. M., to 5 P. M., on one afternoon early in the present month. These were all more or less strange phenomena.

"23. Two descriptions of aërolite fell in this district—that sent in a wooden box (of which but a small fragment was found), fell at Bowarna; and that resembling granite or limestone, fell at the place named, in much larger quantities.

"24. The largest piece that was found of the latter weighed about four munds pucka.

"25. As the piece I examined will not answer to the test of acetic acid, I am of opinion that it does not contain carbonate of lime. I should be glad to ascertain the exact chemical constitution, for I am firmly of opinion that it differs from all other stones or metals of terrestrial origin.*

"26. The accompanying extracts of the more remarkable phenomena may be read with some interest by the Hon'ble the Lieutenant-Governor."

"*Copy of a letter from Officiating Deputy Commissioner of Dhurmsalla, to* R. H. DAVIES, ESQ., *Secretary to the Government of Punjab, No.* 512, *dated* 25*th April*, 1861.

"With reference to your letter No. 683, dated 4th instant, I have the honour to state that I have been making further inquiries with regard to the meteorolite that fell at Dhurmsalla.

"2. No fresh information can, however, be obtained beyond that contained in my No. 927, dated 30th July, to the address of the Punjab Government.

"3. I beg to append copy of a letter received from Monsr. Haidinger, Director-General of the Imperial Geological Institute of Austria, dated Vienna, 14th November, 1860, on the subject of these meteoric stones.

"4. In reply to this letter, I forwarded a copy *in extenso* of my account of the fall of aërolite referred to above, and begged the favour of their furnishing copies to each of the institutions for which specimens were requested.

"5. I packed a box with 14 specimens of the aërolite, and despatched this to the Private Secretary of His Excellency the Governor-Ge-

* "*P. S.*—Probably there are grains of chrysolite in it and perhaps cobalt or chrome as well, but I have no means of ascertaining this. It certainly is not magnetic, but it may be chromic iron.

neral, with a request that he would, after taking out certain specimens which were intended for His Excellency the Governor-General, forward the box to Vienna in the manner directed.

"6. One of the specimens was, as will be observed from the letter, intended for the British Museum.

"7. I have, however, now sent the only remaining two specimens* I could procure to Lahore for transmission to the Secretary of State for India, either for presentation to the British Museum, or the Museum attached to the late India House, or for the acceptance of Her Most Gracious Majesty Queen Victoria.

"8. The specimen now sent is the largest of any that has been despatched from Dhurmsalla; and being beyond the weight authorised for banghy parcels, I was under the necessity of forwarding it to Jullunder by coolies, and thence by government bullock-train to Lahore.

"9. When worked up into handles for walking-sticks or riding-whips, the metallic substance is clearly visible.

"10. As to the precise form of the aërolite no positive information could be obtained, for it was found in fragments, and its intense coldness has been mentioned in the report before submitted.

"11. The original of the letter from Vienna, together with a printed paper giving the falls of former Meteorolites, and an account of them, has been already forwarded to His Excellency the Govenor-General of India.

"12. The specimens for Lahore have been forwarded under separate covers."

III.—Note on the Way in which the Calamine occurs at Silvermines, County of Tipperary. By J. Beete Jukes, M.A., F.R.S.

Descriptions of the mines and ores at Silvermines are given by Dr. Apjohn and my colleague, Mr. Wynne, in previous numbers of our Journal,† and by the latter also in the explanation of Sheet 134 of the Geological Map of Ireland, published in 1861. I beg leave to refer particularly to the latter description, as containing an accurate and detailed account of the mining district. When going over the ground, however, with Mr. Wynne, I could not exactly understand the way in which the calamine was said to occur; and I therefore was glad when an opportunity presented itself to me, in May, 1862, of revisiting the mine, and going underground with Captain King to see the new explorations.

Mr. Wynne's descriptions of the "gossan bed," or mass of yellow ochre, which seems to be now rather largely used for pigment, and the

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* "No. 1, of the fragment that fell at Bowarna. No. 2, of the large stone that fell at Dhurmsalla.

† See Journ. Geol. Soc. Dub., vol. viii., part 2, p. 157, and part 3, p. 243.

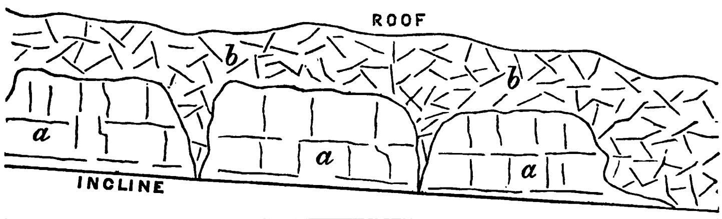
way in which it is mixed up with irregular deposits of earthy calamine, carbonate, and silicate of zinc, appeared to be quite accurate. Captain King said that the calamine deposit went up in irregular mounds into the yellow ochre. I can also confirm Mr. Wynne's account of the occurrence of the irregularly rounded and subangular masses of dolomitic limestone, and parts of beds of this limestone, as if interstratified in places with other substances, or at least as if lying in them with their planes of stratification undisturbed.

I could not help, indeed, coming to the conclusion that these blocks and portions of beds, of the limestone remained in their original places, while all the rest, above and below, as well as around them, had been removed, and replaced by the yellow ochre and the calamine.

Captain King got specimens for me of some of these limestone masses about the twenty-four fathom level, which, even by the imperfect candle light, glittered with crystalline particles of galena. My colleague, M. Alphonse Gages, examined these specimens for me, and found them to be composed of a dark grey limestone, with crystals of dolomite or bitter spar, and of transparent blende, with minute strings of galena, and some iron pyrites.

In the sides of the inclined tramway, below the twenty-four fathom level, I saw some beds of this grey dolomitic limestone, capped by the ochre and calamine, with veins of those substances, several inches wide, running at intervals down into the limestones, apparently along joints, and ending gradually below. The beds of limestone also terminated abruptly against a mass of the ochre and calamine in each direction, somewhat as in the annexed sketch.

SKETCH OF THE SIDE OF THE INCLINE NEAR THE TWENTY-FOUR FATHOM LEVEL.



a, Magnesian limestone, dark grey and crystalline.
b, Brown earthy ochre and calamine.

The great fault which courses nearly E. and W. from Silvermines to beyond O'Brien's Bridge, with a downthrow to the N., becomes an irregular lode, or "mineral vein," between Silvermines and Shallee, containing among other things iron pyrites, galena, and blende. It is simultaneously with this occurrence of ores in the fault that the limestone, brought down by it against the the lower rocks, becomes dolomitic,

and also, in some places at least, contains blende, galena, and iron pyrites.

It appears, then, that water proceeding from this fault, and percolating the limestone, may probably have decomposed the sulphides in the lode as well as those in the limestone, so as to form solutions of sulphates with free sulphuric acid; and thus give rise, by double decomposition, to the formation of sulphates of lime and magnesia, which were gradually removed, and replaced by carbonates of zinc and iron, the latter being gradually changed into ochre.

As most water contains silica, a certain amount of silicate of zinc has also been formed.

The fact of the substitution of the bases had suggested itself also to Mr. Metzmacher, the German gentleman who superintends the dressing and calcination of the ores, with whom I discussed it on my return to the surface.

It is obvious that this explanation has a practical importance, since, if the calamine be merely a partial and irregular replacement of the stratified limestone, by subsequent substitution of the zinc and iron for the lime and magnesia, the circumstances to be taken into account in exploring and working the mine will be altogether different from those in an ordinary lode or mineral vein.

I may add that I also saw, under Capt. King's kind guidance, the new openings for galena made near Shallee. These were in the Yellow or Upper Old Red Sandstone on the rise side of the fault. It appeared to me as if the sandstone had been much shattered or shaken, so that its joints were more open than usual, and that these joints had been partially filled by irregular deposits of baryta and galena; and that the rock itself had also become more or less impregnated by these substances, which occurred in irregular patches or strings, without any distinct lode or vein. The blue colour of the rock, noted by Mr. Wynne in the old workings, was also perceptible in these parts in the neighbourhood of the galena.

IV.—On the Granitic Rocks of Donegal, and the Minerals therewith associated. By Robert H. Scott, M. A.

[second notice.]

[Read December 10, 1862.]

In laying before the Society a second notice, in continuation of that read last year, which is contained in the last number of the Journal, it may be well to state what has been done by the British Association Committee in the way of examination of the county during the last twelve months.

It will be remembered that my first paper was an account of the facts elicited by the President, Mr. R. Byron, and myself, during a tour

in the south and west of the county, made in July and August, 1861. Since that time I have paid two visits to the district,—the first at Easter, in company with the President and Mr. Jukes, and the second in July last, when I was alone. In addition to this, the rocks of Innishowen have been examined carefully by Sir R. Griffith in person, with a view of determining their relation to the subjacent rocks. In furtherance of this object, he is at present engaged on a similar task with reference to the rocks of Scotland, and it is to be hoped that he will lay his views on the subject before the Society at an early period.

The first of the visits which I have mentioned was made last Easter, in company with Professor Haughton and Mr. Jukes, and in its progress we traversed the northern and western portions of the peninsula of Innishowen, crossed into Fanad, visiting the granite at Kindrum, at the extreme northern part of that promontory, and then went on to Dunfanaghy, returning by Gartan Lough. In the second visit I was alone, and spent some time examining the S. E. corner of the county, lying between Belleek, Ballyshannon, and the Bluestack and Barnesmore mountains. In this task I was materially assisted by the same gentleman who aided us to such an extent last year,—Mr. Harte, the county surveyor of the western district,—who is now, I am glad to say, one of our members. This gentleman has been unwearied in his exertions in the cause of geology throughout the year. My head-quarters at this period were Donegal. From this I went to Ardara, and traversed the same district as was visited by the party last year, but was able to devote more time to its examination. I made my head-quarters at Dungloe for some time, in order to investigate that district, comprising the interesting localities of Crohy Head and Arranmore Island, returning by the Guidore, Glenveagh, and Gartan Lough, to Letterkenny.

In the last trip I succeeded in making two sections of the granite, on foot, in fine weather, so that I was able to investigate at my leisure all points of interest which I noticed.

I shall commence the description of the county with an account of the rocks observed in Innishowen, and proceed in a S. W. direction from that barony. In the north of Innishowen the chief rocks observed were grits, crystalline limestone, mica slates, and a variety of greenstones and syenites, passing by insensible gradations into the two distinct types of syenite of Ardara and Horn Head. The whole of these rocks are contorted considerably about Culdaff, and from that to Malin Head they exhibit a consecutive section, of which the dips increase as you go westward, the beds being nearly horizontal (dip 20° to 25° E.) at Culdaff and along the shore towards Glengad Head, and consisting of grits, interstratified with igneous rocks.

The limestone of Culdaff is dark-coloured, and highly crystalline, the crystals being a black variety of calc spar, and in it we observed the concretions which have been already referred to in the Journal (vol. vii., p. 163), in a paper by Mr. P. Ganly. I think that my companions will agree with me in expressing my opinion that their origin is not organic, and that there is, consequently, no ground for supposing them to be the

semi-obliterated remains of fossils, such as *Favosites Gothlandica*, &c., as suggested by the author of the paper. Mr. T. S. Hunt considers them to be similar to travertines.

The grits of this part of the county are true grits, not having been sufficiently metamorphosed to form quartzites, until we reach a more westerly point. Among the beds of mica slate and argillite, we find some which are here, as at Convoy and in other parts of the county, converted to potstone and impure soapstone. We have not yet discovered pure soapstone so far north. These rocks are formed from an anthophyllite slate, which is very abundant throughout the county.

There is, however, a series of beds belonging to the mica slate which are highly characteristic of that part of Ireland—a chalcedonic conglomerate, of which the cement is micaceous, and the pebbles mainly siliceous (of the chalcedonic variety), but consist also of pieces of the mica schist itself, and sometimes also of feldspar. Similar conglomerates to these are described by Mr. Macfarlane* as a characteristic feature of the Huronian series of Canada, and of their Norwegian equivalents, called by Naumann the Tellemarken Quartz Formation, from the district of that name, in the south of Norway.

Keilhau says of them that they occur in repeated alternations with hornblende rock (diorite), as described by Naumann. The cement is micaceous, and the pebbles sometimes felspathic, sometimes quartzose, and sometimes of still more varied natures. In some places the mica schist contains concretions having the appearance of imbedded fragments, and with an aspect from which we must believe that it has been once broken up, and its pieces afterwards irregularly joined together (*Gaea Norvegica*).

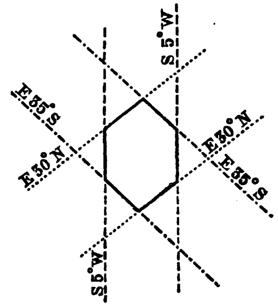
A description of conglomerates similar to these is to be found in the Reports of the Geological Survey of Canada, already referred to, and I am disposed to think that similar rocks have been discovered by Sir R. Griffith in Scotland.

It is very remarkable that the igneous rocks, to which allusion has already been made, as being found in great abundance in the county, in Innishowen, are undoubtedly contemporaneous with the sedimentary rocks of the district. This fact is observable along the coast, but it is noticeable in the most striking manner between Buncrana and Carndonagh, about five miles from the former place,—the whole of the hills lying between Slieve Snaght and the Raghtiu mountains being composed of alternating beds of quartz rock and syenite, dipping at a low angle to the eastward. This is beautifully exhibited in the mountain of Binmore or the King of the Mintiaghs, lying in the district called the Barr of Inch, close to the Mintiagh lakes. This hill, with its consort,

* I should here express the assistance which I have received from Sir W. Logan's and Mr. T. Sterry Hunt's Report on the Rocks of Canada, in the Reports of the Geological Survey; and from Mr. Macfarlane's two papers on the Primitive Formations in Norway and Canada, published in the "Canadian Naturalist and Geologist" for 1862, which will well repay perusal.

the Queen, form a very striking feature in the landscape, when seen from any point in the northern part of the county. I have been kindly permitted by Sir R. Griffith to use the accompanying sketch and section of the hill in question (Plate I.)

These hills and the mountain Bulbin are terraced like the trap hills of Antrim and the coast of Argyllshire; but on a close examination, it is found that, though the conclusions drawn from the terraced form are further borne out by the fact that all the beds are columnar, yet they consist of alternate beds of quartz rock and syenite, as before described. The columnar structure of the former is due to the simultaneous development of three series of joints, inclined to each other at angles approaching those of a regular hexagon. These joints are all of them traceable in other parts of the county; but it is only here that they assume a development of such equal importance.



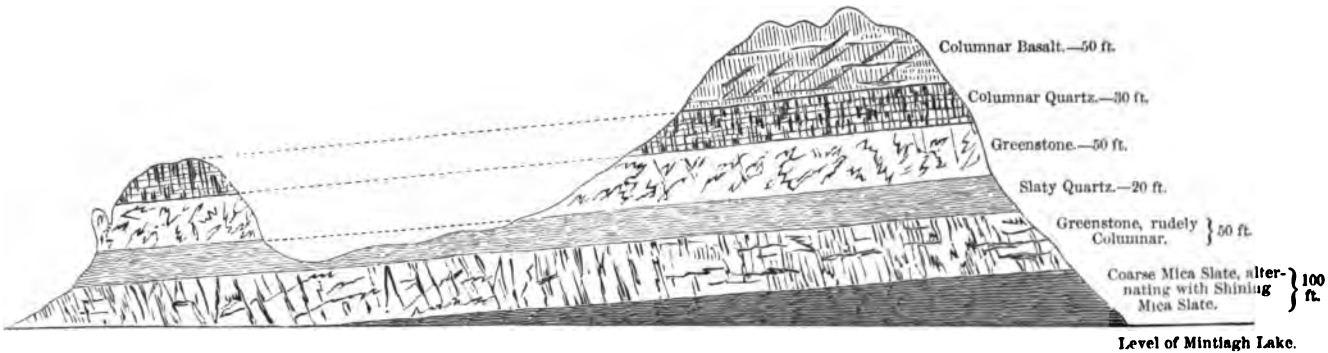
Joints in the King of the Mintiaghs.

It may here be remarked that the types of igneous rock, which have here been deposited contemporaneously with the sedimentary strata, are found to be very similar to those of the intrusive rocks of other parts of the county, *e. g.* of Doonan Hill, close to the town of Donegal.

On passing west from Buncrana towards Dunaff Head, through the Gap of Mamore, it is found that, as we approach the granite at Urrismenagh, the dip of the beds increases from 45° to nearly absolute verticality. The granite of Urrismenagh does not present many features of interest to the mineralogist, as the rocks in immediate contact with it are quartzose, and therefore unlikely to yield accidental minerals.

In crossing from Rathmullen to Milford, you pass over beds somewhat similar to those which have been already described as occurring in Innishowen. We made, however, an excursion from Milford to Kindrum, along the eastern shore of Muilroy Bay, in order to examine the granite at that locality. This we found to be remarkable in its character, resembling the variety which is found at Ardara and Narin, and also in the island of Arranmore, as will be noted hereafter. This granite is in general white, and contains a large quantity of black mica and sphene; however, in some places, both here and at Ardara, there is a considerable quantity of a reddish granite to be found disseminated through it. The nature of this granite is essentially different from that of the typical red granite of Glen Veagh and the Guibarra valley. It is a remarkable fact that all the localities in which this white "sphene granite," as we call it (from the great abundance of that mineral in it) occurs, are separated from the granite of the central valley.

On the road to Kindrum, a little beyond Rossnakill, we found an impure serpentine, a rock which we have not yet discovered elsewhere in the north of the county, though it occurs in the south and west.



SECTION OF THE KING AND QUEEN OF THE MINTIAGHS, NEAR BUNCRANA.

SECTION TO ILLUSTRATE MR. SCOTT'S PAPER ON THE GRANITIC ROCKS OF DONEGAL.

At Glen, which is situated close to the head of Sheephaven, and at the northern extremity of the lake of that name, the central granite ends rather abruptly: it is flanked on the east side by a very peculiar, highly micaceous, gneiss, called in the district "black granite." Of this rock there are two varieties, one of which contains a reddish feldspar, the other a grey one, this latter exhibiting the striæ, the typical characteristic of the triclinic feldspars. This striation arises from the co-existence of a great number of macles of the species, aggregated into a single highly complex crystal. Such striation is always due to a tendency in the mineral to crystallize in a form different from that which the circumstances of its segregation have caused it to assume. Structure similar to this is the cause of the play of colours in labradorite—a property not peculiar to that mineral, as it has been observed, though rarely, in striated orthoclase.

The granite itself is very similar to that obtained on the Board of Works' road, in the Guibarra valley, about two or three miles from Doochary Bridge, being characterized by the presence of the two feldspars, the orthoclase being in larger crystals and of a flesh-red colour.

Close to Glen, on the road to Creeshlagh, we meet with a very remarkable illustration of the nature and relations of the rocks throughout the whole county. A series of quartzites and hornblende slates are met with, the latter passing gradually into syenites. Their strike is nearly east and west (E. 5° N.), and their bedding is vertical. They are traversed, along the strike, by a series of veins of granite, which rarely cross a bed, but still preserve the character of veins, and not of beds, as they are most decidedly not lenticular. Appearances precisely similar to these have been observed by me during my last tour at Toberkeen and at Stackamore, about half a mile north of Leabgarrow in Arranmore. The bearing of this fact on the geology of the county will be explained hereafter.

The chief point which is noticeable about the neighbourhood of Dunfanaghy is the extreme development of a highly crystalline syenite, containing a very large proportion of titaniferous magnetic iron. The octohedral crystals of this mineral are very noticeable on the weathered surface of the rock—one of the toughest it has ever been my fortune to deal with. For the last-named reason we have no really typical specimen of it, as we did not blast it, and so were obliged to content ourselves with smaller specimens than we could have wished. The best locality is immediately about M'Swyne's Gun. The magnetite also occurs in a rock composed mainly of black mica, an occurrence precisely similar to that which it has in some parts of Norway.

The quartz rock of Horn Head is highly characteristic; it is eminently flaggy in its nature, splitting at times into blocks which have at first sight considerable resemblance to fossil Sigillariæ. The quartz rock here belongs to a variety which I am disposed to term the feldspathic variety, as it contains small grains of feldspar disseminated through it, as in a porphyry. This variety is also found at Crohy

Head, although there it is not so flaggy. The flaggy nature reappears again at the north corner of Arranmore. The second variety of quartz may be called "the gneissose," as the extraneous element which it contains is mica. This is developed to a large extent in Arranmore. These two varieties of quartz rock are characteristic of the similar rocks in Norway and in Canada. In the former locality Keilhau especially refers to the feldspathic variety as being very easily disintegrable into sand, and accordingly, when it alternates with pure quartzite, producing very striking configurations of the surface of the ground, owing to the different resistance offered by the various strata to the action of the weather. It is a remarkable confirmation of this that the well-known Muckish sand occurs in the immediate vicinity of beds of this feldspathic quartz.

The other variety of quartz rock is mentioned by Sir W. Logan, in the Report to which reference has already been made, in the following words:—"The quartzites have sometimes the aspect of sandstones, and at other times lose their granular texture, and become a vitreous quartz. Not unfrequently the quartzite is thin-bedded, and even schistose in its structure; and it sometimes holds a little mica, passing into a variety of mica schist." In Mr. Macfarlane's paper he alludes to both varieties as occurring in Norway.

We have not as yet visited the tract of country called Cloghaneely, which lies between the Clady River, Muckish, and the sea, comprising the headland called Bloody Foreland. The road from Dunfanaghy to Dunlewy would have gone along the strike of the beds, and have been accordingly comparatively uninteresting.

On my last tour I made a section, on foot, from the Guidore Hotel through Glenveagh to Gartan Lough. I passed through the Poisoned Glen, and over the Gap of Ballaghgeeha into Glenveagh: from that I went over the shoulder of Altahostia, and round Lough Inshagh and the foot of Carrowtrasna down to Gartan Abbey, thus effecting a complete section of the granite across the central portion of its area. On the former excursion, Mr. Haughton and I had crossed the granite by the new bridge and the Gap of Barnesbeg, while Mr. Jukes took the road by Owencarrow Bridge. In this way we have obtained three different sections at points lying to the north of the col between the Glenveagh and Guibarra valleys. The results of all these sections are very nearly identical. In the very heart of its area, the granite, judging from hand specimens, is true granite; but when seen in the field it is stratified, the strike of the beds being nearly coincident with the axis of the valley, and their dip nearly constant in amount, and uniformly to the eastward. In addition to these granitic beds, there are numerous others, which become more abundant as you approach the edge of the district, which would be pronounced gneiss, even from an examination of hand specimens. This fact, which has been abundantly confirmed by observations in other parts of the county, places the gneissose character of the rock, as a whole, beyond a doubt. The gneiss on the eastern edge of the granite, especially near Fintown, and also

near Trawenagh Bay, is remarkable for the extraordinary development of crystallized orthoclase of a red colour which is to be seen in it, giving it an appearance very similar to that of the feldspar veins at Castle-Caldwell which are worked for the production of the materials for the manufacture of porcelain. Here, as at Castle-Caldwell, it contains the black iron mica which is so detrimental to the quality of the ware, and so difficult to remove from the raw material.

As a further illustration of the gneissose character of the granite, I shall draw attention to the fact that, on my way down from Ballagh-geeha Gap to the point where the road turns off to Glendowan, where you have an extensive area of granite, nearly half a mile wide, and almost divested of heather, which is therefore admirably adapted for examination, I found small portions of highly contorted gneiss contained in the granite, and apparently caught up in it. This I have observed in several other localities, as mentioned in my former paper, especially in the neighbourhood of Bunbeg; at Lough Anure; Annagary; above Gartan Abbey; at Toberkeen; Lough Pollrory, near Trawenagh Bay; in Glenleheen; and near Lough Errig. These portions of gneiss are sometimes of slight extent, and sometimes, as at Lough Errig, they extend for some distance (I traced one for 50 yards). Such an appearance as this is usually accompanied by the presence in the granite of highly crystalline metamorphic limestones, as at the head of Glenveagh; again under Altahostia, half-way down the lake; at Glenveagh Bridge, and at the Gap of Barnesbeg. Their occurrence at Annagary and Glenleheen, was noticed last year. With reference to the last-named locality, I found that the limestone there occurred in four distinct beds, possessing a strike of E. 5° N., which is coincident with that obtained from the rocks at Lackagh Bridge. The appearance in each locality is not absolutely continuous, but their identity of strike in different localities points to four distinct parallel beds of limestone. I am led to consider the three deposits of limestone in Glenveagh to be parts of one and the same bed.

There appears to me to be a line of demarcation noticeable between the gneissose granite of the Guibarra and Glenveagh valleys and the more highly crystalline granite of the western part of the Rosses, as that district of the county is called. This line seems to be indicated by a series of deposits of limestone, which are found at points situated not very far distant from each other—such as Bunbeg, Annagary, Lough Anure, and Meenatotan. These localities lie on a curved line, extending for about twelve miles, and which, I am led to think, might be traced further towards the mouth of Trawenagh Bay. This curve embraces the Dungloe district.

In illustration of this relation of the rocks to each other I may again quote Mr. Macfarlane, who says, after giving a synopsis of the rocks to be met with in the primitive gneiss of Norway, which he compares to the Laurentian rocks of Canada:—

"As to the mode in which these rocks are associated with each other, the whole of them are arranged in parallel layers or zones,

side by side; underlying or else overlying each other. Hitherto no regular succession of rocks has been marked; they appear to be interstratified with each other without rule. The granitic masses are partly conformable with the parallel masses of the schistose rocks, and partly occur irregularly. It has been remarked that, when the granite becomes more or less gneissoid, its masses are regularly interstratified with the other schistose rocks; but where the granite is totally free from all traces of gneissoid texture, the form in which it occurs deviates more or less from that of layers or beds. A remarkable instance of this is described by Keilhau, as occurring near Norefield. There he saw a mass of granite, which on the whole was gneissoid and bedded, gradually change at a certain place into a perfect granite, and then, in complete uninterrupted continuity pierce the rock in the form of a dyke. Another instance is mentioned of a granite rock occurring in the schistosc rocks 'partly in very regular layers, partly as isolated knolls and lumps, and partly as a multitude of veins; which in several places run through large portions of the neighbouring mountains as a close network.' In spite of this, however, this granitic rock showed, in many places, a gneissoid structure. The relations of the hornblende schists and greenstones resemble those of the granite. The hornblende schist is regularly interstratified with the gneiss, mica schist, and other rocks."

I have been induced to make this long quotation, owing to the great analogy which it represents as existing between the county Donegal and the Scandinavian peninsula. Similar facts have been observed on the coast of Newfoundland by Mr. Jukes, as he stated to us in the field this spring. Sir R. Griffith, many years ago, observed the facts which I have here recorded as observed by us, at Lackagh Bridge and in Glenleheen, and saw their importance in the interpretation of the structure of the county. As to what Macfarlane says at the end of the quotation about the hornblende schist, it will be remembered that I have already alluded to its occurrence at Lackagh Bridge. Last year we only ventured to point out the similarity in mineralogical constitution between the granites of the two countries.

The fact that in Donegal this gneissose granite pierces other rocks is abundantly proved by the occurrence of granite dykes cutting the limestone at Drumnaha Gap, two or three miles from Fintown, and in Dunlewy marble quarry.

It appears also in a very striking manner at Pollnacally near Trawenagh Bay, where it is intrusive into quartz rock, and sends veins into hornblende rock; and also at several localities on the south shore of Arranmore Island.

I have alluded to the limestone of Barnesbeg Gap. This is an isolated patch, apparently unconformable to the granite, and is full of garnets and idocrase, with large quantities of sphene in the rock which lies besides it. The sphene rock, which we described last year as occurring next to the limestone, is composed of orthoclase, green pyroxene, and quartz, with a considerable quantity of sphene dissemi-

nated through it. In this rock I have discovered, at Glenleheen, the well-known Norwegian mineral "scapolite," which has never been acknowledged by British mineralogists as a native species, although Sir C. Gièsecke notified its occurrence at Holy Hill, Strabane, in the year 1830. In addition to this, my attention has been drawn by my friend, Dr. W. Frazer, to some specimens of the same mineral which were found many years ago at Killala, county Mayo, by our late lamented member, Archdeacon Verschoyle, which are in the collection of the Royal Dublin Society.

Mr. T. Sterry Hunt, on seeing our sphene rock, recognised it at once as an old friend. He says of it:—"Associated with the Laurentian limestones there are frequently found beds of a coarse-grained rock, made up of white feldspar and dark green pyroxene, with brown sphene, and occasionally with quartz. The feldspar is found to be orthoclase."*

I have brought from Annagary some interesting specimens, showing this rock in immediate contact on the one side with limestone, and on the other with syenite, which passes into granite.

In the beds of limestone at Bunbeg and Annagary, the minerals already named are associated with white tremolite and epidote. The latter mineral is found well crystallized at Drumnaha. At Aphort, in Arranmore, we have a similar bed; but here the garnets are no longer of the opaque variety common in the Rosses, but are clear and highly coloured; idocrase appears to be absent; and the epidote is developed, not in the limestone, but in the adjacent gneiss.

Sir Charles Gièsecke says that he found moroxite (apatite) in association with these minerals at Annagary. We have not as yet found it there, but I am disposed to consider some small blue crystals which occur at Barnesbeg to be this mineral.

Another mineral which is highly characteristic of the schistose enclosures in the granite is a rare mineral, which I consider to be fibrolite, the white variety of kyanite. It is found at Croaghnamaddy, near Toberkeen, and in very good crystals at Annagary and at Lough Anure. Its occurrence is very similar to that of andalusite, but its fibrous fracture and crystallization distinguish it sufficiently from that mineral. It is a remarkable fact that andalusite, similar to that of Lugduff, occurs in great abundance at Narin, on the south side of the granite.

The next locality of interest which presents itself to us is Crohy Head. In the examination of this district I derived most valuable help from the rector of the parish, the Rev. F. Corfield, who entertained me most kindly, and, from his knowledge of the country, materially aided my researches. In this headland we find the deposit of soapstone which was referred to last year. There are four beds of it, and a similar deposit is found at Gartan Lough and elsewhere. Its

* This rock is well known to the quarrymen of Canada as the next bed to the limestone; they call the crystals of sphene *bed-bugs*.

strike at Crohy varies from S. E. to E. 25° S. If we follow up one of the beds along the strike, from its appearance in the cliff just under the coastguard station, we find at a point about 100 yards inland a deposit of verde antique marble, which was discovered and pointed out to me by Mr. Walker, who is at present residing at Maghery. This marble and the soapstone are associated with anthophyllite slate, which rock may be considered to give rise to soapstone whenever its basic element becomes mainly magnesia.

Crohy Head itself consists, to a great extent, of quartz rock. The mountain of Croághegly is formed by a bed of syenite, which runs into the sea at Pollnacally, where it is penetrated by granite veins. The beds lying to the east of this are gneiss. The quartz rock is of the feldspathic variety; and from the strike of the beds we should expect to find their continuation, with the soapstone, in Arranmore. On visiting that island I found that such a conclusion was a very erroneous one, as the strike of the rocks in Arranmore is different from that observed on the opposite coast. I spent the greater part of two days on the island, and have to thank Mr. Crowe, the contractor for the light-house, for his kindness in allowing his foreman, Mr. Smith, to accompany me on my exploration of it. I should here state that the difficulty of reaching it has been very much exaggerated. The sound is only three miles wide, and may be crossed, either by the north or the south passage, in any excepting very severe weather. Leaving Dungloe at an early hour, you can spend six or eight hours on the island, and return to Dungloe the same evening. I should not advise any geologist to waste his time in going farther to the north than Pollawaddy, as the cliffs from that all round to the light-house, on Rinrawros Point, are in most places unapproachable for his purpose, varying in height from 50 to 500 feet. Along this coast, half-way between Bellachreesh Bay and Altcreeverly, I climbed down to the only bed which I could discover in the island which resembled soapstone, but without being able to satisfy myself whether a deposit of that mineral existed there or not. The sandstone at the N. E. corner of the island is very flaggy, like that of Horn Head.

From Leabgarrow to the Chapel Strand, we find a peculiar coarse-grained granite, which resembles that of Barnesmore and of Murnell's Rocks, near Pomeroy, in Tyrone. It is characterized by the presence of dark red feldspar, abundance of quartz, and the great rarity of mica. It takes a good polish, and is obtainable in enormous blocks. Mr. Smith and I measured one, on the shore under the grave-yard, which was completely exposed on the surface, and would afford a squared slab 90 × 20 ft. Its thickness I could not ascertain. This is the only slab which I have seen which would be comparable with Pompey's Pillar and the obelisks from Ceylon; and it is to be remembered that it is not an undeveloped monolith, like some that were suggested last year, but is lying there for any one to measure and take away if they can.

This granite is different from that of Burton Port, and the adjacent

district of the Rosses, which is remarkable for its containing the two feldspars in extreme abundance, as mentioned last year.

Close to the chapel at Illion, in Arranmore, I found the pipe-clay, which has long been known as a production of the island. On going from this point to the westward, along the south coast, I was surprised to find loose blocks of white "sphene granite," with which I was quite familiar from its occurrence at Ardara and in Fanad. In Arranmore the crystals of sphene are finer and more abundant than elsewhere, and the rock forms the whole of the southern shore of the island from Rossillion up to Cladaghillie. At Tordhu it contains some syenite and gneissose rocks, the whole forming in places a network of veins, as was so well described by Keilhau in the quotation which I have already made from his writings.

This granite, with the other rocks of the island, as well as the granite near Dungloe, is penetrated by numerous dykes, some of ordinary trap, others of amygdaloidal pitchstone, and some of a very remarkable felstone porphyry. This latter is found between Tordhu and Cladaghillie, and is columnar.

From the point where the granite strikes inland, at Cladaghillie, to the south-western extremity of the island, the rock consists mainly of the gneissose variety of quartzite, before referred to; and the island of Illanaran appears to be composed of the same rock. There are numerous dykes of igneous rock, some of which are similar to the syenite so often referred to as occurring in the county Donegal. At one point on the west coast, called Polldhu, which well deserves its name of "The Black Hole," syenite of the Horn Head type appears in the form of a vertical dyke, which throws out lateral intercalations along the bedding of the adjacent quartz rock.

The scenery round the whole island is some of the finest I have ever seen on the coast of Ireland; and a walk along its southern and western shore is not fatiguing, as the whole of the slopes close to the cliffs are covered with short grass, and are very dry underfoot. The north shore is covered with heather, and is very wet.

The remainder of my tour was in a district which we had before examined, and of which therefore I have not much to say. I have already noticed the discovery of andalusite near Narin; and in the same part of the county, close to Lough Laragh, I have discovered molybdenite, accompanied by actynolite, disseminated through elvan. I came on it by chance, when looking for a bed of limestone which is marked on Sir R. Griffith's Map. The molybdenite is very different in appearance from the same mineral as it occurs at Garvary. In the former place it is in veins in granite, at Lough Laragh it is in hexagonal plates.

The granite of Bluestack and Barnesmore is of a different character from that which I have been describing, and it resembles that of Pomeroy in its consisting mainly of dark red feldspar. It is penetrated by a great number of pitchstone dykes, which are many of them

amygdaloidal, and are most abundant in the mountain of Tawnawully, opposite Barnesmore.

The granite also contains numerous quartz veins, some of which are amethyst, the best of these being in the bed of Barnes River, above the lake of that name. Other veins consist of smoke quartz in graphic granite; these are found on Brown's Hill.

In this part of the country we also find ilmenite (titanic iron), which was frequently called rutile by the older mineralogist; it is found disseminated through quartz. There is however a mineral of more interest to us than this, inasmuch as it affords another point of relationship between Ireland and Norway—I refer to nickeliferous magnetic pyrites. It will be remembered that our President read a notice of its occurrence at Maam, county Galway, in the course of the year before last; and that Mr. Emerson Reynolds sent us a notice of the occurrence of nickel in mica slate at Curraun, Achill, county Mayo, while Mr. Mallet discovered millerite at the foot of Croagh Patrick. Magnetic pyrites, containing traces of both nickel and cobalt, is pretty common about Barnesmore mountain. Mr. Macfarlane notes the deposits of nickeliferous magnetic pyrites in the south of Norway, as an important object of mining research, although they only contain two or three per cent. of the valuable metal.

The last mineral to which I have to draw your attention is kyanite, which occurs in great quantity in mica slate, together with schorl, garnets, and sphene, in a peculiar reef of rocks which extends in a straight line from near Fin M'Coul's Pan, at Ballykillowen, to the N. W. corner of Lough Derg.

Lastly, I wish to lay before the Society a specimen of Rockall granite, which was brought home by the Captain of H. M. S. Porcupine, on his return from his cruise in that neighbourhood, and which I have received through the kindness of Mr. Harte: as soon as its analysis is completed, I shall communicate it to the Society.

V.—Sketch of the Geology of the District of Shorapoor, or Soorpoor, in the Dekhan. By Captain Meadows Taylor.

[Read June 11, 1862.]

The district is situated between latitude 16° 15′ and 17° 15′ N., and longitude 76° 25′ and 77° 25′ E., and contains an estimated area of 3240 square miles. It is bounded to the west by the British territory of the collectorate of Sholapoor, of the Bombay Presidency, and for the rest by the Krishna and Bheema Rivers, the Krishna being to the south and east, the Bheema to the north and east, till their junction.

Up to the year 1858, Shorapoor was an independent principality, held by a family of the Beyder tribe or caste, which rose to power under the Beejapoor Mahomedan dynasty, about 350 years ago. In 1841, the late rajah's father (who had mismanaged his affairs very sadly) died, leav-

ing one son, about six years old; and his wife, being a violent and profligate woman, unfit to manage the affairs of the state, was set aside, and a Regent appointed, with a political officer to guide him and instruct him in the necessary reforms. I succeeded to the office in 1842, and, the Regent dying two years afterwards, was appointed civil and political superintendent, in which office I continued till the Rajah attained his majority, in 1853, when his territory was made over to him.

He afterwards became disaffected; and, in 1857–8, joined a plot for insurrection in the southern Mahratta territory, which was discovered and checked; but not before he had risen in open rebellion against the British Government, and attacked a force sent for the protection of an officer who had been despatched to endeavour to induce him to abandon evil counsels. The Rajah was defeated by the British troops, fled, and was taken, tried, and sentenced to death; but this sentence was commuted to a term of close imprisonment. He was on his way to undergo this, when he shot himself, whether purposely or accidentally is not known. The district was annexed temporarily, and in 1860–61 given to the Nizam, as a mark of favour, in return for his good faith during the rebellion, and it consequently remains in his possession.

My duties in the revenue and political departments obliged me to visit every part of the district very frequently, and I thus acquired a minute acquaintance with its geology, which I shall proceed to *sketch* broadly in its principal features, rather than to dwell minutely on any particular portion of the subject.

I am anxious that the geology of this tract should be know ncorrectly, because in a map of the geological structure of the Dekhan, indeed of Western India generally, published I believe by the Geological Society, Shorapoor is included, wholly, in the great granite field of Southern India; whereas, it is not altogether granite, but contains portions of trap, limestone, and sandstone, in connexion with granite, which are disposed in a somewhat remarkable manner: and it is the only tract I know of in India, in which these formations lie in actual contact.

Commencing at the south-west corner, near the hill fort of Juldroog, the first remarkable object is the ravine into which the Krishna River falls from the plateau of the Dekhan, which extends from the fort, upwards and westwards, for about two miles, till it is crossed by an immense mass of granite, over which the river falls, not at once perpendicularly, but in a series of very steep rapids and great and small cascades, the steepest portion of which is about half a mile long, and about 500 yards broad. The total height of these falls, from the island above to the pool below, is nearly 400 feet: so that it may be imagined how grand the sight is, when this immense river, flooded in the monsoon, dashes over these cataracts with prodigious noise and fury. There are, indeed, few finer scenes of this description in the world.

The great denudation of surface produced by the river's action, discloses a bed of wonderful form and colour. The granite here assumes almost a blood-red colour in many parts, owing to the high tint of the feldspar; while the hornblende appears in the form of irregular cubes, of

about an inch each way, in a porphyritic character. The rock is more beautiful, I think, than any Egyptian granite or syenite that I have met with. The bed within the river is intersected by many broad veins of actynolite, the colour of this mineral being of great beauty, in some parts nearly approaching to malachite in appearance; and the remarkable greenstone dyke, which is so prominent a feature in the hills at Shorapoor, crosses the bottom of the ravine, near Juldroog, having preserved exactly the same direction, namely, S W. and N. E. throughout its course.

It is impossible to describe the fantastic groups into which the granite has been thrown, or that it has assumed, consequent upon surface denudation, on the left bank of the river. The piles of rocks, of all conceivable forms, and in all kinds of positions, defy description, and, in connexion with the cataracts of the river, form some of the most picturesque scenes, as well as the grandest of their character, with which I am acquainted.

Northwards and eastwards from the falls, are a series of low granite hills, much confused, with narrow valleys between, covered with low, scrubby jungle, which border the small river Done, lying in a deep bed. This river rises near Beejapoor, and, after a course of about 80 miles, falls into the Krishna, opposite to Juldroog. The water is so salt, that cattle even will not drink it. About seven miles from the junction, up the river, the first sandstone is met with in its bed; and tracing it eastwards, immediately north of the town of Koricul, it is found to disappear under low limestone bluffs, from 20 to 30 feet high. The boundary of the granite continues to trend in an easterly direction; and at the point at which it has joined the sandstone and limestone, a little west-southwest, between the villages of Teerth and Rajunkolloor, the effect produced upon both formations is very singular, the heat of the granite having partially fused, or at least altered the character of both in an evident manner.

The sandstone is primitive; of coarse grain, and variously coloured in ribbons as it were, blue, light and dark grey, white, yellowish-white, pink, deep madder-red and brown, alternating horizontally, as if the rock were stratified. A German missionary declared it to me to be identical with the "Bunter" sandstone of Germany, and it probably is so. This point is the most northern which true sandstone is known to attain in the Dekhan, and from hence it spreads out to the south-west, occasionally changing into millstone grit, and being seen in great beauty at the hill fort of Gujundur Gurh, sixty miles south: the precipitous sides of which, with those of the adjacent hills, show it for upwards of two hundred feet in all its variety. The sandstone composing the hills there has been lifted up as it were out of its bed in the earth by the granite, which is below, and appears cropping out under the sandstone.

Immediately north of Teerth and Rajunkolloor, and upon the limestone, here lying perfectly horizontal, lies a bed of trap formation, which, occupying the top of the hills, is perfectly level, and affords some fine

rich soil from the disintegration of the formation. This trap is connected to the westward with the vast trap and basalt field of the Dekkan, which knows no break afterwards till it reaches the sea; and at the point I am now describing, the border of that great eruption is reached, which passes in a northerly direction to the Bheema River.

This trap mud, as I will call it, is very shallow, and lies upon the limestone. In no locality that I have seen does it exceed thirty feet in depth, and is most frequently from twenty feet to ten, and even less. It has exactly the appearance, as was no doubt the fact, of being the last wave of the great volcanic eruption of mud which rolled eastwards, and was stayed here; for, except on an isolated hill of considerable height near the edge, there is no trap east of this border. The mud is indurated, but is readily resolvable into its original element by pounding it, or crushing it, with water. It has dried into small cubes, and is of a greyish-brown, or yellowish-brown colour. Interspersed with it are nodules of basalt of all sizes, from a stone as large as my fist or head—to rocks three and four feet in diameter. The surface is strewn with these rocks and stones, which are completely denuded of covering for the most part. Those, however, which are still partly embedded in the mud, show that the process of exfoliation is going on; and it is evident that these stones, rolled slowly onwards; gathered about them the tenacious volcanic mud, which, in the layers surrounding the nucleus stones, has the same appearance and specific gravity as the indurated mud itself. The exfoliation process is exactly similar to peeling off the coats of an onion, each coat or crust being so distinct from the other, as to be readily separated, and usually containing between each coat, a small portion of ochrey oxide of iron.

Further west, cellular trap is met with, which again passes into prismatic basalt; and there are instances of these formations also in Shorapoor, which will be detailed in their proper places, as also of beds of grey volcanic ashes.

I have said that this trap rests upon horizontal limestone. This also is a peculiar formation. I believe it was first brought under notice by the late Captain Newbold, F. G. S., and termed by him "Kurnool limestone," as Kurnool, where he then resided, was entirely of this formation; but it is by no means confined to one locality; and, passing through Shorapoor in a south-west and north-east direction, continues under the trap, appearing at intervals, till it finally disappears at Chincholee, under the great laterite plateau of Ekailee and Beeder.

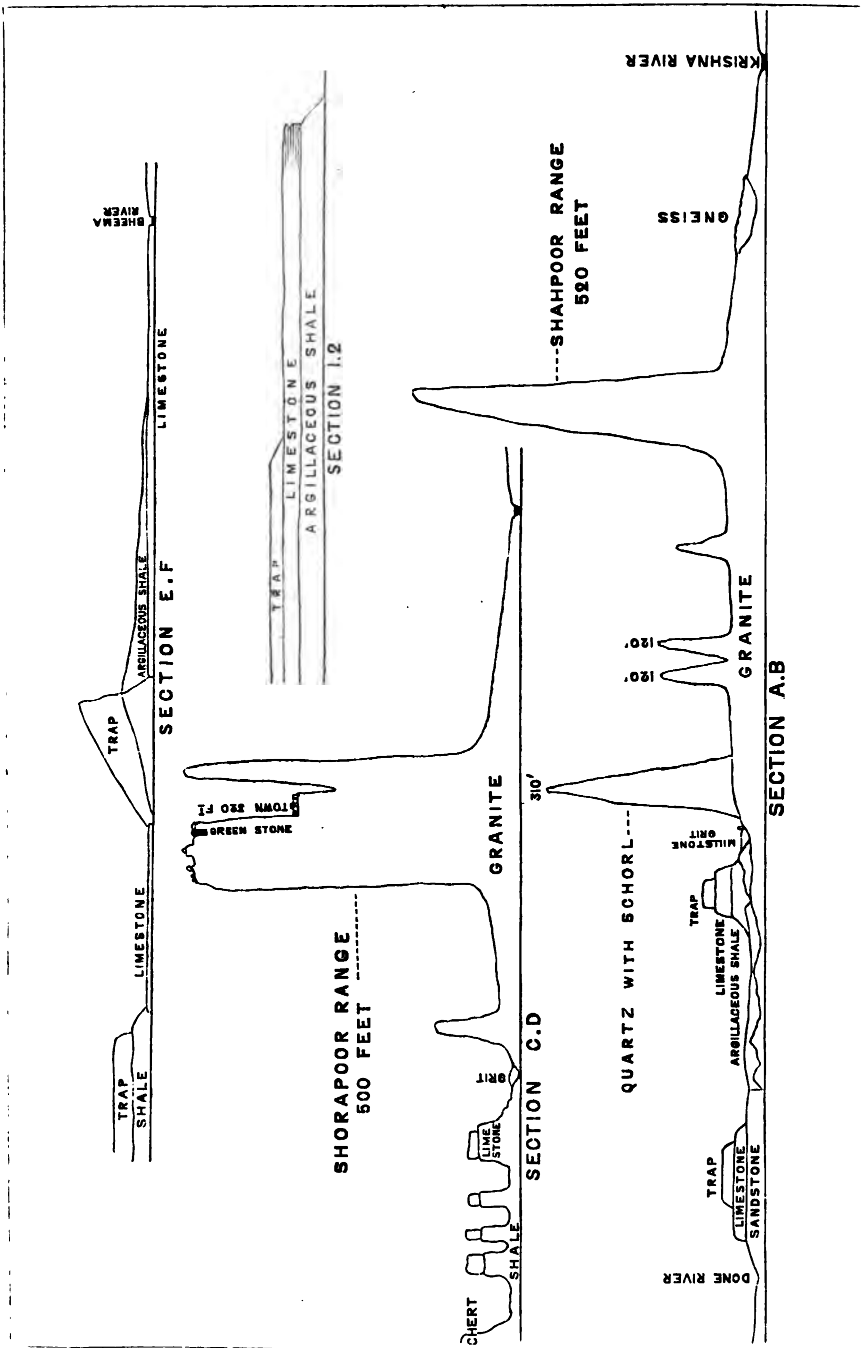
In colour and texture it is very similar, for the most part, to lithographic stone, but contains a greater proportion of silica, which renders it unfit for lithography, except of a coarse description; but some portions sent by me to the Revenue Survey offices were used for printing village maps. The colour varies from a deep bluish to the most tender shades of dove colour and yellowish-white. It is laminar, the laminæ being from one to two inches, to two and even three feet in thickness, lying perfectly horizontal, except where disturbed by any subterranean

plutonic agency. The rock breaks with a conchoidal fracture, and is frequently very hard, giving forth a ringing metallic sound when struck with the hammer; and the structure of each lamina is stratified or veined,—the veins, not unlike those of agate, being perfectly horizontal, agreeing with the upper and lower surfaces, and slightly differing in tints of the same colour, sufficiently so for the veined appearance to be noticeable.

This description of the trap and limestone will answer, I trust, as general, and applicable to these formations in all localities of Shorapoor. Wherever anything particular needs remark, it will be mentioned.

The trap on the limestone at Rajunkolloor extends to within four hundred yards of the eastern termination of the hill, and I give in Section 1, 2, Plate II., a section of this hill, showing the contour of the trap and limestone, and the formation, till it joins the granite below the end. Below is the granite—above it, argillaceous shale, friable, consisting of thin laminæ, mostly horizontal, but occasionally disturbed. It partakes of the colours of the limestone, warm greys, and dove tints, with others of bright madder-red, pink, bluish-grey, purple, and other combinations of these colours. The thickness of the shale at the point of the hill, where the limestone forms a scarped bluff, is from 30 to 50 feet, forming an angle of about 45°. Above this, the limestone is 25 to 30 feet in height, laminar—the laminæ being from 1 to 3 feet in thickness. The top of the hill, until the trap is reached, is nearly denuded of earth, in some places entirely so; and the surface rock is found to be generally smooth—here and there traversed by thin vertical veins of quartz, and in one place, a little to the north-west of Teerth, by veins of hæmatite, one of which is very beautiful, the mineral being a pure dark blood-colour, and of very close texture.

I must here mention one peculiarity of this limestone which has interested me very much, and in regard to which I have as yet arrived at no satisfactory conclusion. The surface rock upon this bluff, as also on the next promontory north of Wujul, and generally throughout the whole district, though in some localities more than others, is found to be perforated by small holes, lying closely together, and irregularly disposed. Some of these are larger than others, and they vary from the sixth and eighth of an inch to a quarter of an inch in diameter. Occasionally slabs are found in which these holes lie as close to each other as the several diameters will allow; again, upon others, they will be in strings and lines irregularly crossing each other—or in groups—in short, conforming to no law or system whatever. In some instances the perforations are quite through the stone, where it is not very thick, but they are of all depths, from a quarter of an inch to a foot—sometimes, in general indeed, vertical, and in others somewhat divergent to one side or another. The sides of these holes are generally nearly smooth, and again slightly ringed, as it were. I regret I have not a specimen here to exhibit to the Society. I brought a large piece of the rock from India with me, and showed it to Professor Jukes, with a view to his forming an opinion upon the nature of the perfora-



SECTION TO ILLUSTRATE CAPTAIN MEADOW TAYLOR'S PAPER ON THE GEOLOGY OF SHORAPOOR, IN THE DEKHAN.

tions, but I do not know that he has decided the matter as yet. I have given the specimen to the Geological Society of England, and it is now in their museum; but if this Society considers it of any value, I have no doubt I could get a piece of it for the museum. The Geological Society examined what I sent, and have also failed to come to a conclusion.

Briefly, the point to be decided is this—are the perforations those of Pholades, or effected by any other agency? and if so, what agency?

I referred this question to Dr. Carter, who is Secretary to the Royal Asiatic Society at Bombay, as well as to the late Dr. Buist, both at the time ranking among our best practical geologists of India, with different results. Dr. Buist agreed with me that the perforations were those of marine insects, Pholades, and received the testimony of these rocks as absolutely, in his opinion, confirmatory data of the theory of the upheaval of the whole continent from the sea. Dr. Carter would not, however, admit this; but said at first, that the holes must have occurred "from grains of sand being whirled about in natural cavities of the stone, gradually increasing them in depth." After seeing specimens, and being informed that there was no sand in the country, he admitted that his first opinion was erroneous, and suggested, instead, that the perforations were caused by roots of "arums" which grew on, or above the stone, while it was soft. I myself still adhere to my first opinion on the subject, because, if the holes had been caused by roots, parts of such roots, which had filled the holes, would probably have remained fossilized; while, if the roots decayed, it is hardly possible to suppose that the holes they had made in a soft mass of what may be supposed to have been mud could have remained, under the action of water, so perfect as they are now found. Finding some of the holes full of foreign substance, I was in great hope that they might be fossils, but in all cases they proved to be small deposits of manganese. After my arrival in England, I compared the specimen I had brought with perforations caused by Pholades in limestone, and was much struck by the exact similarity. I cannot, however, take upon myself to decide the question; but I think it of importance as affecting the age of the rock, and the theory of upheaval or otherwise of the Peninsula, and should be much gratified if the Society could consider it. I am not aware that the Geological Society of London have come to any decision upon it, though it has been several times, as I was informed by the secretary, under consideration.

I will now refer to the several sections, of which the diagrams are given on a scale of nine miles to an inch horizontal, and 360 feet to an inch vertical.

Section AB begins at the sandstone at the south-west corner of the country, on which the bed of limestone and superincumbent trap already described exists. The sandstone passes under the limestone, and appears on the other side of the hill in a basin of limestone, which has been much disturbed by upheavals of granite. Here the strata or laminæ, no longer horizontal, are found in all directions, and at all sorts of angles, some

even vertical. The red patches of colour show the protrusions of granite through the crust of the limestone, and it is curious that in some places the granite has not protruded itself through the limestone to the surface, but has remained beneath, near enough, however, to be seen, and to have caused a corresponding dislocation of the stratum above it; but in no locality that I could find, except that near Teerth, has the eruption of the granite produced any effect of fusion upon the limestone or sandstone.

The same kind of dislocated limestone, interspersed with granite protrusions, lasts to the village of Wujul, where, though granite is seen in the bed of the river, it has not disturbed the horizontal strata of the limestone above it. Here are hot springs, which discharge a large body of water into the river, sufficient indeed to irrigate a considerable number of rice fields and gardens. The springs issue from the floor of a small temple which has been built over them, and is evidently very ancient. The temperature of the water is 92°, and varies little, if anything, by season. It is pure and soft in quality, but insipid in taste. Passing these springs, limestone continues; and a second hill, similar in character to the first, is crossed, but is somewhat higher in elevation. Here also is trap above, limestone below it, denuded and perforated as at Rajunkolloor; and the specimen in the possession of the Geological Society was taken from the end of the hill where the surface soil has long ago been completely washed away. Below the limestone here is the same argillaceous shale as before described, which continues to the stream, in the bed of which rocks of granite, passing somewhat lower down into millstone grit, or a rock which is used for millstones by the stone-cutters. The ground now rises rapidly; and a ridge, lying nearly north and south. about 350 feet high at its highest point, is crossed, which is almost entirely composed of quartz rock, resting upon granite. On the west side, and as you pass up the small stream which comes from the north, beds of curious breccias are met with, composed of nodules of granite, trap rock, quartz, and other minerals, cemented by tufaceous lime. On the top and east-sides of the small range of hills, beautiful specimens of schorl are met with in beds of pure quartz, which I have never noticed elsewhere in the Dekhan. After passing it and two smaller ranges of granite hills, that formation continues without any interruption, to the Shahpoor Hills, which are of considerable height, 520 feet, or thereabouts, above the plain: at the north-eastern corner of which is the celebrated hill fort of that name, a remarkably strong place, well provided with water in natural cisterns in the rock, which never fail. In the plain beyond the hills, which undulates down to the Bheema, a small portion of gneiss occurs, followed by granite of the usual character. The Shahpoor Hills are remarkable for the denudation of their summits, as indeed are all the granite hills of this and other districts adjacent; and the extraordinary piles of rocks which are everywhere seen, of the most extravagant, and seemingly impossible construction, are objects of the greatest interest.

Section CD begins at the trap on the western frontier, or, more

properly speaking, in a large bed of chert which passes into trap. Descending a hill about 100 feet high, which consists of trap mud, with basalt nodules, as before described, about 50 feet thick, which lies upon limestone and argillaceous shale, as in the hill first described, it intersects the first section at the limestone bluff, crosses an outlying hill of the quartz range, here become granite, and passes over the Shorapoor range, and town of Shorapoor. The range of Shorapoor is, like that of Shahpoor, isolated, rising directly out of the plain, and of considerable height, the highest point being about 500 feet above the plain. The town lies on an irregular plateau, the highest part of which is 320 feet above the plain, and is only broad enough to contain it. The tors and denuded rocks of this range are, if possible, more extraordinary than those of Shahpoor, and specimens of them are given in Diagrams 1 and 2, Plate III. After passing Shorapoor, the country declines gradually to the Krishna without interruption.

Near Mudnoor there is a basin similar in some respects to that of Wujul (Section 1, 2). Beginning at the frontier with chert and trap, the descent is of the same character as that described in the last section. In the valley the granite has disturbed the limestone, if possible, even more than in the first basin noticed, and the dislocations of the strata are very remarkable. A limestone bluff, immediately north of the village of Mudnoor, however, remains in its horizontal position, and abounds with pyrites, from which some sulphur is extracted. At the village of Mudnoor, close to the small river, are two hot springs, of great strength, which discharge at least double the quantity of water of that at Wujul. It suffices not only for the irrigation of much of the land on the right bank of the stream, but provides a stream in the bed of the river, which is always flowing. The water is pure, and retains a temperature of 88° at all seasons, in the spring itself.

The centre of this basin is considerably depressed; and about half a mile west from the village of Bychbal are brine-wells, 120 feet deep, which are used for the manufacture of salt. The brine when raised is very clear, and has a strong smell of sulphuretted hydrogen gas; but this soon passes off, and the salt, when made by evaporation, becomes as nearly as possible a pure sulphate of soda. The salt made here supplies a large portion of the districts. Gypsum of very pure quality is raised from the bottom of the wells.

Near the town of Kembhavi a remarkable instance of granite protrusion occurs in an isolated rock, having lifted with it a portion of limestone, which covers it like a cloth. The limestone is about six feet thick.

The next section, EF, shows no granite, which has ceased to exist after passing the Mudnoor and Bychbal basin, and begins at trap on the west, lying upon limestone. Limestone fills the centre of the valley; trap then rises gradually to the crest of the plateau eastwards, which again descends upon argillaceous shale, and thence into limestone, as far as the Bheema. The shales here join the trap, and are of the same quality and colour as those before described; and the bed of limestone, here

and there disturbed by granitic eruptions, is at a lower level than the shale, which most likely has been upheaved by granite beneath. At a short distance from Mululi, the limestone ceases altogether, and trap succeeds, which does not change afterwards.

North-east from Mululi, about six miles, a ridge of trap formation rises gradually, which forms an extensive plateau of considerable elevation, probably 400 to 500 feet above the river Bheema. On this plateau the trap passes into prismatic basalt; and instances of very regular prisms occur in a small stream near the village of Ijeyri, where in its descent from the table-land a small stream falls over a bed of prismatic basalt, causing a cascade of 15 feet in height. On the northern side of this plateau partial denudation by small streams discloses hills of bluish-gray and brown volcanic ashes lying under the mud.

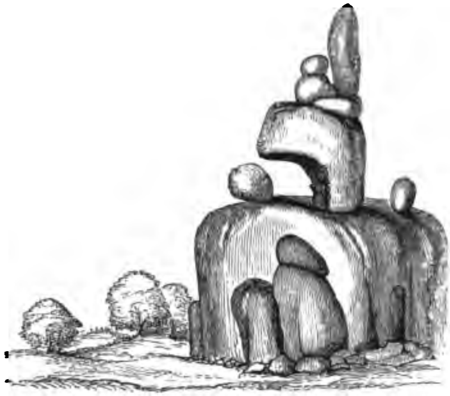
I need not follow the remainder of the formation of the district, in which the rocks are limestone to the east, which has been undisturbed, as it everywhere presents a perfectly horizontal character, with the same surface perforations as before noticed; to the west, trap of the usual Dekhan character, which is not afterwards interrupted by other formations. On the left bank of the Bheema the same formations proceed—granite to the south, trap to the north and west, and limestone in the centre—which continues almost unbroken to the laterite plateau, a distance of sixty miles north-cast.

The main interest of the geological structure of the district rests, perhaps, with the limestone. It is clearly an older rock than some of the granite which has so obviously disturbed it, and it is older than the trap, which has partially covered it; but if the perforations be those of marine insects (Pholades), I am at a loss to assign it a place relative to its age. Probably, however, this formation may be known from other reports, which have determined a period to it, independently of the position and circumstances in which it is found at Shorapoor. I have not been able to find any fossils in it or in the shale on which it rests.

A description of the various minerals which are found in connexion with the rocks of this district would convey no new information, and I therefore do not particularly allude to them. The granite, or more properly syenite, is interesting from the variety in its texture and colour, caused by the preponderance of one or other of its component parts and the different tints of the feldspar, ranging from pure white to rosy red, and many of its forms are most wonderful and curious. Of these I have given examples, which could be multiplied *ad infinitum*.

Many of the groups of denuded rocks are of the most majestic dimensions; one in particular, at Shorapoor (Plate III., No. 1), which is the highest point on the western range of hills, is upwards of 100 feet high—perhaps 120, for it could not be ascended to be measured. It stands upon another huge, round mass, which is imbedded in the mountain, and only partly denuded. As these rocks lean together so as to form a chamber, the place is used by the people of the town for pic-nics and excursions with their families. In the hottest weather it is cool here, and the view all round is extensive and beautiful.

No. 5.



No. 6.

No. 7.

No 8.

TO ILLUSTRATE CAPTAIN MEADOWS TAYLOR'S PAPER.

No. 1.

No. 2.

No 3.

No. 4.

TO ILLUSTRATE CAPTAIN MEADOWS TAYLOR'S PAPER.

Plate III.—No. 2, is a group of rocks, curiously balanced one on another, in the Shorapoor hills, 47 feet in height.

No. 3 shows a group in which a rock, having fallen from above, has been caught between the surrounding rocks. This group is 56 feet high to the highest point.

No. 4, also at Shorapoor, and called the Frog Rock, from its striking resemblance to one sitting, especially from a distance; 46 feet from end of rock to earth; the rock itself about 50 feet long.

Plate IV.—No. 5 is also at Shorapoor, and was in my own grounds, forming a corner of the plateau. I had a flight of rough steps built to the level portion, which was surrounded by a wall, and used as an observatory. The pointed rock is 91 feet in height: the girth is very large.

No. 6 is a curious natural rock near Kopal Droog. The hollow rock is 35 feet in height; the whole, to the top of the point, about 60 feet in height.

No. 7, a bend in the river Toong Bhuddra, near Bejanugger. The river here flows through a narrow valley of denuded rocks and hills; and the whole forms one of the most wonderful and picturesque regions of denuded rocks that can be conceived. Many of the hills are 500 feet high, consisting of piles of these rocks, perfectly hollow throughout.

No. 8 shows a group at the entrance of the narrow portion of the valley of the same river, about two miles below Humpee.

It is remarkable, perhaps, that most of these strange rocks must have been cast up when cooled, for their forms have not altered; but in the largest masses, especially where lying horizontally, indications of the stone having been soft, and only partially cooled, exist in the falling over of the sides; and this has been compared, not inaptly, to one feather-bed laid over another—a feature which is always remarkable when any denudation of the side of a hill has exposed the rocks in the form of a natural section.

In 1842, at the time the great comet was visible, there were two sharp shocks of an earthquake at Shorapoor; but, with one or two exceptions, none of these piles of rocks were displaced.

VI.—On the Geology of parts of Sligo, &c. By A. B. Wynne, F.G.S.

[Read January 14, 1863.]

The papers already published in the Journals of the Geological Societies of London and Dublin, by Archdeacon Verschoyle, Sir Richard Griffith, and Mr. John Kelly, together with Sir Richard Griffith's geological maps, explain the geology of parts of the country so fully, that a short description only will be necessary.

In this part of Ireland, lying near the north-west coast, the country is occupied by a great series of nearly horizontal limestones and sandstones of Carboniferous age, resting upon a floor of what may be hereafter found to represent the upper part of the Irish Old Red Sandstone, and crossed in a N.E. and S.W. direction by the mica schist and gneissose range of the Ox Mountains, extending by Slieve-Deane along the south shore of Lough Gill to beyond Benbo Mountain, in the county of Leitrim.

A small outlying patch of these gneissose and schistose rocks, which protrudes through the limestones in a peninsula to the N.W. of the town of Sligo, is mentioned in a paper read several years ago before the Geological Society of London, by Archdeacon Verschoyle. The occurrence of this outlier is important; for we may, perhaps, presume from it that the basement of the whole country is formed of these old rocks, which in all probability, if uncovered, would present a rugged and uneven surface, with eminences such as that exposed here, surrounded and covered by the Old Red Sandstone, and succeeded by the thick series of nearly horizontal calcareous rocks, which rise at a short distance from the sea into mountains of considerable height, reaching in some instances to elevations of over 2000 feet above the sea, on the north side of the older range, and extending inland, carrying with them for long distances their characteristic tabular shape, and being separated from each other by deep precipitous glens and open valleys. On the south side of the Ox range, the country becomes flatter, taking much the appearance of some of the central parts of Ireland; but rocky hills, formed of the nearly horizontal limestone beds, rise also from the open valley, between these and the Curlew Mountains, near Boyle; at places not far from Ballymote; and towards the elevated Connaught coal-field, in the vicinity of Lough Allen and Lough Arrow.

The extension of the Ox Mountains, formed of the old quartzose, micaceous, and gneissose rocks, has an aspect so widely differing from the limestone mountains to the north and south, that any observer might speculate upon their being formed of different materials. In the part of the country to which these notes refer, the older mountains have heights of 800 and 900 feet above the sea. They are formed of naked, or but slightly covered, rock, and have various massive, rounded, and rugged outlines, indented by many deep transverse ravines (or, as they are called in that country, "Alts"), some of which are fully equal in depth to a third of the height of the mountains, and others have been excavated to the level of their base.

In the neighbourhood of Benbo Mountain, and also near Lough Eask, granite is indicated upon Sir Richard Griffith's Map: the former of these localities only was visited, and the nearest approach to granite seen was a more compact and finer grained variety of the local gneiss, at the top of the above-named mountain.

Masses of green serpentine occur in two places associated with these rocks, one of them cuts across the range at right angles to its direction, coinciding with the bottom of Rockwood Glen, on the south side of Lough

Gill, and striking generally N.N.W. It is divided by a marked set of regular north and south planes, about a foot apart, with slickenside layers of greenish-white silicate of magnesia between them, and these have an inclination to the west, at about 45°. Three other minor sets of planes were also observed to cross the serpentine here at different angles.

Another exposure of this rock occurs near the old mine of Lurganboy, at the north foot of Benbo Mountain, where it seems to occupy a fault between the limestone and the older rocks. It was likewise traversed by regular planes bearing N.N.E., and dipping west at 10°; and in one place it contained so many garnets, that it might be called garnet rock. These two were the only places at which anything, besides the micaceous rocks, quartzites, and gneissose rocks, was seen; but it is stated that large trap dykes also occur here and there, some of which are alluded to in Archdeacon Verschoyle's papers.

Looking at and over the east end of the old micaceous chain from some of the neighbouring hills one is struck by the fact that the limestones and other horizontal rocks have been immensely denuded from about it, so as to form long lateral valleys, coinciding in direction with the flanks of the range, which now occupies the place of what would have been but inconsiderable hills, if they had appeared at all above the formerly existing plateau, of which the upper surfaces of the tabular mountains are the only remnants.

Besides the difference in the nature of the rocks, another cause for these lateral valleys,—indeed, for one of the most strongly marked of them, which forms the basin of Lough Gill—may be found in the circumstance that the junction between the limestones and the older rocks is apparently effected by a fault, as may be seen at Dhunea rock, a great limestone crag at the south side of the lake, the lines of bedding of which strike directly at the gneissose mountain which rises close behind it.

Again, at the north foot of Benbo Mountain, where another lateral valley starts from the head of this one in an opposite direction, the limestone near the old mines dips at 45° towards the micaceous gneiss and serpentine rocks in and near a stream which passes by that place on its way to the Bonet river.

It is probable that other faults exist in the country. The serpentine at Rockwood may occur in one, and another appears to cross the Ox range, near Ballysodare.

The fine, nearly horizontally stratified, group of mountains, embracing the eastern termination of the Ox range, exhibits the structure of the country there in a remarkable manner. From Benbo Mountain the general lie of the rocks may be observed for miles to slope gently away from the older chain, although in detail the beds are found in places tilted against it; this gentle inclination of the strata passes into low wide undulations, and the beds rise again slightly towards the sea-board, as seen in the precipitous profiles of Benbulben and Knocknarea. The latter mountain is a remarkable isolated pile of limestone beds, rising 1078 feet above the sea, with a low dip to the southward. It is steep-sided to the S.E., and on all the other sides precipitous, and it doubtless formed

a rocky island when Sligo Bay occupied the valley of Lough Gill, and arms of the sea extended into the narrow friths or fiords formed by Glencar and Glenade.

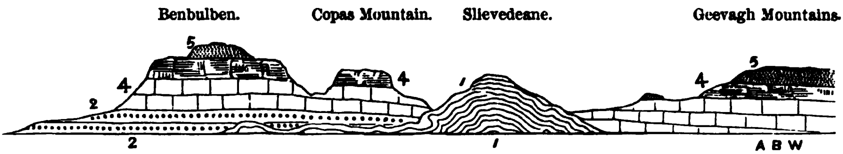
The country about the head of the Lough Gill valley is broken into a number of detached flat-topped hills, one of which bears a marked resemblance in miniature to Knocknarea, and another from its shape is called O'Rourke's Table. They appear to be chiefly composed of dark grey thin-bedded cherty limestone near the lake; but to the eastward pale splintery limestones are more frequently found, and the hills, although still abrupt, become less tabular and more rounded in their outlines.

On the north side of this valley of Lough Gill, between the tract of broken ground and Glen Car, a high crooked limestone spur runs out from Benbo by Culloguboy, and terminates in Copes or Castlegal Mountain. To the east it is formed of pale splintery much-jointed limestone, with intercalated dun-coloured magnesian bands; but its precipitous western slopes expose both the compact grey and lower dark thin-bedded limestones, in such situations as apparently to have been brought together by faults. This appearance might also result from a partial concealment of the beds in the steep mountain sides.

In the Dunally river, which rises between Copes Mountain and Culloguboy, are some dark brown, olive grey, and whitish dry-looking sandstones with black shaly partings, lying below the bedded black limestone (containing many corals), forming the mountain on either side; they contain carbonized and other remains of large plants, with some impressions of coiled shells, and they present much the appearance of upper Old Red Sandstone beds. The Carboniferous limestone here perhaps shows signs of the splitting up into alternations of siliceous and calcareous deposits, such as are known to represent it in the north part of the British Isles.

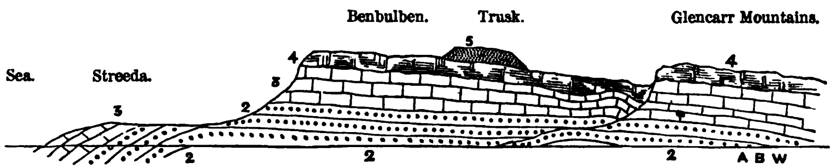
The characteristic aspect of all these mountains is probably best exhibited in the Benbulben range, and there is a strong contrast between them and the older mountains. Benbulben is said to resemble Table Mountain in appearance, and the peculiarity of the *group* which first strikes an observer is their strong likeness to each other in profile (Plate V.) Their flat tops are bordered by a cliff escarpment or breastwork of varying heights, cut through here and there by "alts" or ravines; and from its foot there slopes a steep *glacis* at an angle of 35° or 40° from the horizon—formed, like somewhat similar slopes in the Burren Mountains in Clare, of the projecting beds which are here, however, dressed, like the slopes of a railway, by the atmospheric debris crumbling away from the cliffs above. This may be seen where the shingle has been removed, and the rock appears close to the surface, beneath the cliffs called the Protestant Rocks. At Copes Mountain (the legendary scene of a battle where the vanquished were driven over the steep cliffs into the valley of Glencar), the change in the outline of the mountains, from the vertical to a high slope, may mark a period when the forces of elevation were gradually exerted after they had remained

IDEAL SKETCH SECTION N. & S. ACROSS THE COUNTRY EAST OF SLIGO.



1 Micaceous and quartzose sandstones and gneiss.
2 White and olive flags and sandstones.
3 Dark shaly limestone, with beds of sandstone and magnesian limestone.
4 Pale splintery limestone.
5 Millstone grit.

IDEAL SKETCH SECTION, NEARLY E. & W. THROUGH BENBULBEN TO THE SEA AT STREEDAGH.



2, 3, 4, 5 } Same as in Section above.

SECTIONS TO ILLUSTRATE MR. WYNNE'S PAPER ON THE GEOLOGY OF SLIGO.

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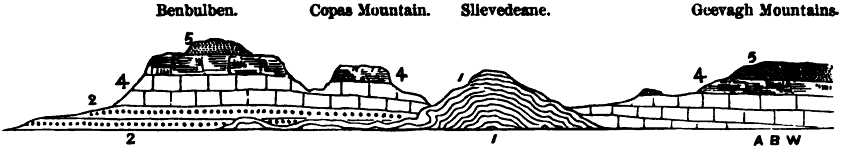

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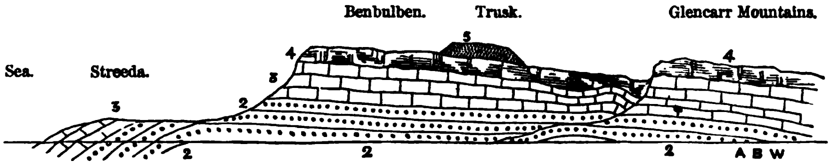

2, 3, 4, 5 } Same as in Section above.

SECTIONS TO ILLUSTRATE MR. WYNNE'S PAPER ON THE GEOLOGY OF SLIGO.

quiet or nearly so, while the cliffs above were being formed; but it should be stated that this line of cliff is not now parallel to the horizon—a circumstance which was also observed in the Burren mountains, formed, like these, of the Carboniferous limestone.

Benbulben stands upon a floor of nearly horizontal sandstones, similar to those already mentioned as occurring in the Dunally River, except that the white dry-looking sandstone, with carbonized plants, &c., seems to occur in greater quantity; over these are some nine hundred or a thousand feet of thin black shaly limestones, containing many kinds of corals, fenestellæ, crinoids, and some shells—the most characteristic fossils being *Zaphrentis cylindrica*. These beds are succeeded by paler grey limestones, in which the stratification is less distinct—both kinds contain magnesian bands, and there does not seem to be any strongly marked division between the light and dark coloured groups. The vertical cliffs are nearly all formed of the thin-bedded limestone; the other is found on the plateau above, apparently thinning out to the west, and the whole are surmounted by about 400 feet of sandstones, forming two smaller mountains, rising like great cairns from the plateau, and called Truskbeg and Truskmore. The sandstones here are coarse, ferruginous and white siliceous beds, containing a few plant impressions, and corresponding to the millstone grit on neighbouring parts of Sir R. Griffith's map. The limestones immediately beneath them appear to be aluminous, and from these part of the dorsal spine of a fish was obtained, which was some inches in length. The plateau at the base of Trusk is covered with deep peat, except in a few spots where the grey limestone shows itself, *Polystichum lonchitis* flourishing in nearly all the fissures; and there are in several places great circular holes passing vertically down, like sandpipes, through the beds, some of them being very deep, and several yards across.

The streams which leave the elevated plateau of Benbulben find their way, in most cases, through the alts and ravines down its sides, but in some instances they run to the edge of the precipice and then fall sheer over as at the "water flights" in Glencar, where a considerable streamlet, on reaching the edge of the cliff, when met by a current of wind up the valley, is blown upwards into the air in the form of spray. Another on the Glenade side of the mountain near Tumpau. falls over a perpendicular cliff in a constant shower of small drops.

At several places round this mountain landslips along faults or joints in the limestone, generally parallel with the direction of the cliff, have taken place, sometimes leaving deep chasms with vertical walls between the separated portion and the mountain. These are strewn with immense blocks, the bedding of the outer portion having been evidently shaken and sometimes altered in position as the separated mass was shifted from its place. Tumpaun, at the west side of Glenade, is a fine example of one of these; and another, in Glencar, still shows the external steep slope of the part of the mountain which has apparently subsided to a lower level.

At the western foot of Benbulben the limestones have been denuded so as to expose the underlying floor of whitish sandstones which surround its base, and form low ground in the direction of Cliffony; but the same limestone beds, apparently, which form the lowest portion of Benbulben, dip seaward at Streeda, and undulate over the promontory upon which Lissadill is situated. At Streeda point they contain a grand assemblage of corals, particularly the *Zaphrentis cylindrica*, many of which lie about, and project from the largely-exposed slightly-sloping beds, like stumps in a cabbage-garden, and one is almost disappointed to find that they cannot pull them up; some of them are from 18 inches to 2 feet long, and 2 and 3 inches in diameter. Whole beds of *lithostrotion* occur here too, some of the clusters being from 4 feet to 2 and 3 yards long, and a foot high; there are also many shells of large *Producta scabricula*, &c., and Spirifers, the former being generally found with the convex side uppermost.

In Glencar some peculiar-looking beds of black sandstone occur near the church, and above them are thin flaggy olive sandstones, with plant remains, the whole being apparently interstratified with the dark thin shaly limestones, and perhaps a part of the same beds which have been stated to occur (on the other side of the mountain from here) in the Dunally river. Further eastward, the limestones near Lurganboy also contain flaggy whitish sandstones; and a closer examination would probably show their existence in many places.

Glenade exhibits fine cliff sections of the horizontal dark grey and black limestones. At the lower part they appear to be very shaly and black, and the drift banks, composed of these rocks, from its dark colour give the name to the Black or Duff River, running into Donegal Bay. The picturesque lake of Glenade supplies the Bonet River, which crosses the run of the older rocks, between Manorhamilton and Lurganboy, curving round Benbo, and finding its way again across the chain through a valley at Drumahaire, into Lough Gill.

At Lurganboy there are apparently several faults and mineral veins. Mines were opened on the latter, and both copper and lead were worked; but the mines were closed up when visited, so that the direction of the lodes could not be seen.* From the debris at the mouths of the pits, the containing rock appeared to be pale siliceous grit, like that at Silvermines (Co. Tipperary); and in some cases, limestone. Magnesian limestone occurs also near Lurganboy, and a peculiar group of conglomeritic and sandstone beds, which may possibly represent the Old Red Sandstone, occurs close to the gneissose and micaceous beds of the older range.

At the end of Glencar, next Lurganboy, a dyke of crystalline green-

* Dr. Boat mentions the occurrence of one of the three mines of lead and silver then known in Sligo, on Coney Island, in the harbour. Some galena is stated to occur at the Rosses Point; and Sir R. Griffith mentions lead, copper, and barytes at King's Mountain, part of the Benbulben chain.

stone extends east and west by Castle Car, coinciding with the general direction of the glen, midway in which it is situated; it may be traced for about a mile and a half, and may have had something to do with the direction in which this part of the glen was formed. The outcrop of the limestone and coal-measure rocks may be seen to slope away from the gneissose chain towards the S. E., producing terrace-like lines in the hills in that direction, but these are not nearly so bold as Benbulben and the adjacent mountains.

Time did not permit of an examination into the glacial action in this district; but great mounds of drift occur within the glens, and at their mouths, and between Lough Gill and Ballysodare Bay. In a gravel-pit in one of the latter, some mussel shells were found at a considerable depth in the deposit, about two miles from the sea, apparently, and possibly *in situ* in the gravel. Some perched boulders of gneiss occur on the top of a limestone hill north of Benbo Mountain: one of these, resting upon a pedestal of splinty grey limestone, exhibits what may probably be an instance of the atmospheric removal of the limestone, the neighbouring parts of the rounded limestone hill having been washed away, while the weathered-looking pedestal was protected by the boulder which it supports.

The changes in the features of the country during recent geological periods may have been considerable; and the waters of Lough Gill, only twenty feet above the sea, may have found another exit than their present one by the River Garwogue, running through Sligo; for I am informed (by the Right Hon. John Wynne) that the trunks and roots of large trees have been taken from a peat bog, now under the bed of the river, between Hazlewood and Cleveragh, and at a depth of some feet below a reef of black limestone rocks, like those at Ballinode, which crosses the stream close to the town of Sligo. A hollow, that appears to have once been the course of this river, extends from its broadest part by Ardowen and Ballinode, past the workhouse to Sligo harbour, and a slight elevation of the land near Sligo would apparently divert the river into Ballysodare Bay.

Small peat bogs and marly deposits occur in hollows of the drift, &c.; and in some of these at Holywell, &c., the sculls and bones of fossil deer and cattle have been found.

In conclusion, it only remains to be said that the country to the westward presents fine geological features, the rough and rugged outlines of the hills taking many varieties of form and aspect. Great erratic boulders may be found at the north base of the Ox range, near Dromore West, as well as high up upon the hills. And, further west, the locality of Easky is interesting, as Lord Enniskillen tells me, on account of its fossil fish.

A visit to this picturesque country would, no doubt, reward a geological inquirer, and many subjects worthy of his attention, besides what have been alluded to here, would, no doubt, be met with, as well as many interesting fossils, of some of which the following list, by Mr. Baily, gives the names:—

Note on the Fossils collected by Mr. Wynne in the Counties of Sligo and Leitrim, by W. H. Baily, F. G. S.

NEAR GLENCAR CHURCH, COUNTIES OF SLIGO AND LEITRIM.

Lower Carboniferous.

Plant Stems and Fragments,
Streptorhynchus crenistria,
Modiola MacAdami,
Sanguinolites plicatus,
} in micaceous sandstone.

GLENCAR CHURCH.

Lower Limestone Shale.

Large bivalve, probably *Leptodomus*.
Groups of small *Orthoceras Steinhauerii* (?) crushed, and having indistinct transverse striations, in black shale, from gully, near the church.

Lower Carboniferous.

Nautilus biangulatus, loc. (?) Co Sligo.
„ (*Discites*) *sulcatus*, abundant; ten on quite a small piece of stone. Co. Sligo.
Archæocidaris Urii (spines), pale grey limestone. Top of Glencar Mountain, townland Stracrehouse.
„ „ Castle Car, Glencar, Co. Leitrim.
Euryocrinus concavus, head.
Cyathocrinus planus, heads, Castle Car, Glencar, Co. Leitrim.
Polypora papillata, and crinoidal remains, on surface of black shaly bed.

KILSELLA, CO. SLIGO.

Lower Carboniferous (?).

Large plant, stem coarsely ribbed, (*Sagenaria*) (?) $1\frac{3}{4}$ inch in diameter, in micaceous flag.

Lower Limestone Shale.

Chætetes tumidus, long branching coral, from beds of impure limestone above the sandstone.
Lithodendron junceum, beds above the sandstone in stream.
Cyathophyllum ceratites.
Glauconome pulcherrima, from shale bed.
Athyris plano-sulcata, from shale bed.
Strophomena depressa, from shale bed.
Orthis Michelini, from shale bed.
Spirifera bisulcata.

TRUSK, SUMMIT OF BENBULBEN.

Lower Carboniferous.

Coarsely-ribbed plant stems, from grit beds near top of Trusk.
Impressions of rain drops.
Tracks, and surface markings.

S. OF TRUSK.

Carboniferous Limestone.

Fragment of the dorsal spine of a fish, which was originally seven inches long, (?) *Tristychius minor*, according to Mr. Wynne's description.

TUMPAUN, BENBULBEN.

Carboniferous Limestone.

Athyris plano-sulcata, with marginal expansion.

MARA HILL, ROAD TO LURGANBOY, NEAR BENBO.

Carboniferous Limestone.

Zaphrentis cylindrica, siliceous, weathered specimens, showing structure.
Lithostrotion affine (?) detached coralites.

VII.—A Sketch of the Geological Structure of Finland. By H. J. Holmberg, of Helsingfors.

[Read January 14, 1863.]

Finland is a region which has been, until within the last few years, but little known in a geological point of view. Thirty-eight years ago, Carl Otto Bremer, Chief Inspector of Foundries, published a work under the following title:—"Guide to the Ores and Minerals of the Principality of Finland," which contained the then existing geological knowledge of our country. Simultaneously with this work the reports of Westling, Savenius, Tengström, and others, appeared, and with them the more detailed description of the country commenced. Bremer's information was chiefly derived from investigations carried on in the last century, so that he is by some authors considered to be antiquated; he is, however, the only authority for many districts of the country.

The reports which have been alluded to are kept in the archives of the Office of Mines, and contain many facts relating to the geological structure of the country. A few years ago I determined to avail myself of these works, and to attempt to construct a detailed account, which might form a basis on which other investigations may afterwards be

founded. The present data are insufficient for the preparation of a geological map, but I shall endeavour to give a general sketch of the geology of the country.

As soon, according to the hypothesis of Laplace, as our solar system was formed, that is, as soon as by gradual cooling the gaseous mist had coalesced to form rotating bodies, existing in a fused condition, whose surfaces slowly hardened to a solid crust, begins, properly speaking, the history of the earth. But this is—just as the history of mankind has its dark period—at first only the age of myths and hypothesis. The ancient records of geology do not appear, until the first organic beings present themselves, which during thousands of years became developed, increased, and disappeared, to leave room for other more perfect existences, and to be themselves buried in the mineral strata, where geology now rediscovers them, like an almost illegible hieroglyphic on the leaf of a historic record.

In a science so exact as geology, no other theories ought to prevail than such as are based upon facts; nevertheless the human mind, which first in the present century has elevated geology to the rank of a science, has by very ingenious hypothesis given apparent probability to the conclusions it has drawn respecting even the mythical ages of the earth. Resting upon these, I have endeavoured to draw the following geological sketch of the obscure corner of the earth which we name our Finnish Fatherland.

Finland, according to its present political boundaries, does not exhibit any of the so-called stratified unmetamorphic formations, in virtue of which its geological history should be lost in the obscurity of supposition. It constituted, in the very morning of creation, when neither animals nor plants could flourish here, a continent of the rocks which still appear in abundance on its surface, and remained in this original condition until the most recent period of creation, when man appeared, took it in possession, and, by his labours, enriched it with his culture. The soil of Finland has accordingly not participated in the general revolutions which destroyed organic existences and prepared other new ones; but formed only a stage for the mighty vicissitudes, at a time when the surface of the earth, with its outer crust scarcely cooled, was still exposed to the impress of the glowing internal fused mass.

The thinner the crust of the earth was, the easier it was broken in the contraction it must have suffered in consequence of cooling. In parts it was lifted up or cast aside by newly solidified masses; in parts it cracked, and into the clefts the elements of new minerals penetrated, which are now found again in veins and dykes. These later formations are distinguished, especially in granite, by a coarsely crystalline texture, which is explained by the fact that the fused mass, which penetrated to the surface of the earth, only gradually cooled. In Finland three ages have been observed in granite, in which, naturally, the veins running through the principal mass of rock have been assumed to be the more recent. But a more accurate study of the Plutonic rocks will undoubtedly put us in possession of arguments in favour of the existence of many

ages in the granite, particularly if varieties from different parts of the country be compared.

Though the surface of the earth had already been for some time hardened, it still continued so hot that no water could exist upon it. The water, of course, remained in the state of vapour in the atmosphere surrounding the earth. It was not until the temperature of the crust had fallen so low that the watery vapour became condensed, that it was precipitated upon the earth, whose surface it almost entirely covered, because no great depressions as yet existed in that surface which could hold large quantities of liquid. From this time the water plays an important part in the history of the earth's development. It appears as a new element, contending with the fire, and subsequently not only takes an active share in all the revolutions which modify the surface of the earth, but also presents a medium of nourishment and place of refuge for the first organic beings which inhabited the globe.

Finland was, therefore, once covered with water. Between the revolutions above described, that is, between the appearance of the primitive granite and syenite and the condensation of the water, several thousands of years must have passed away. During this period the surfaces of the mountains must have undergone many changes from the continued action of the atmosphere loaded with hot watery vapours. A weathering on a grand scale was in fact induced thereby. The granite and syenite were in part chemically analysed, in part mechanically separated, and gave rise to new formations, which likewise were thousands of years in preparation, and which we shall hereafter recognise under the denomination of metamorphic rocks. Inasmuch as water covered Finland, their separated and divided constituents were in part dissolved, in part washed away, and formed in the valleys chemical and mechanical sediments, as was the case with all geological formations, which harbour the remains of an extinct organic world, and may still in the present day be observed in the mouths of rivers. The deposits took place in layers, whence, after they hardened, the varieties of stone so formed acquired a stratified texture. We call them metamorphic or crystalline strata, when, from the heat of Plutonic rocks breaking forth afresh, they were changed into a crystalline mass, which still, in great part, retained its stratified texture. The position in which we now find these strata indicates the operation of a powerful influence from the interior of the earth; we hardly ever see strata in their original horizontal position; usually they are not only uplifted by the protrusion of granitic masses, but they are also bent at an angle, so that they no longer rest in a horizontal position.

This view of the origin of the crystalline strata is not entertained by all geologists, but it is nevertheless the most probable. Some consider their origin to have been contemporaneous with that of granite, and consequently assign them a place among the primary rocks. Yet this assumption depends on many other circumstances than on the, not yet satisfactorily answered, question—How is this origin of the slaty texture explained, if it be due merely to the influence of fire? On the other hand,

again, the metamorphosis assumed by many is also pushed quite too far, when by crystalline strata are understood even the first disturbances of creation, or, in other words, the lime and sandstones of the Silurian formation, which, by the influence of fire, should have been changed not only into a corresponding kind of slate, but also into laminæ of mica, talc, &c. Even if all the remains of an organic nature contained in the lime and sandstone have been destroyed by the outbreak of glowing masses from the interior of the earth, and if the limestone was, at the same time, changed into marble, and the sandstone into quartz rock, &c., it still remains unexplained how gneiss and mica slate could occur, because the mica, which is an essential constituent of both these rocks, neither was present in the Silurian strata, nor could be formed from them. It is much more probable, that each kind of slate acquired its constituents, as has already been mentioned, through the disintegration of the primitive Plutonic rocks, and that the chemical and mechanical deposits already spoken of, which were subsequently changed by Plutonic influence into crystalline masses, took place long before the occurrence of any organic life upon the earth.

After all the varieties of metamorphic rocks as gneiss, mica—clay—hornblende—talc—and chlorite—slate,—and, in part, quartz rock, had been formed under water, the elevation suddenly followed, which made Finland *terra firma*. To the rocks appearing here simultaneously with this elevation of the land, belong diorit, rapakivi, and porphyry. The sea, which washed the southern coast of Finland, and harboured the first organic beings of creation, deposited the latter in beds of mud on the plains of Estland and Ingermanland, where they are now met with in a fossil condition in the Silurian strata. But for such action the same sea found here in Finland no field. With the occurrence of the Silurian formation in our adjoining countries, the elevation of the Finnish coast was, however, not concluded; it still continues at different times, and in the interior of the country are observed not only many partial elevations, but also depressions, and to our time inclusive we take into account the elevation of the land, perceptible only in centuries.

As Finland has none but metamorphic stratified deposits, or, in other words, no fossiliferous strata to show, I shall only say a few words about the alluvial formations of the country.

This is the most recent metamorphosis of the surface of the earth. Its occurrence is due partly to chemical, partly to mechanical forces, which from the commencement of the most recent periods of creation are still in action. The extensive plain of East Bothnia, which was originally the bottom of the sea, has arisen from the gradual elevation of the land; many delta formations, beds of rivers, &c., are in Finland of an alluvial nature. To the same the gold-bearing soil of Kuusamo district might almost be referred, if its origin could not actually be proved to belong to the diluvial period. It is to be observed that Finland, which has no animal remains from the older Neptunian formation, can nevertheless from this period show representatives both of a sea and fresh water formation. To the first belongs conchiferous earth; to the

second siliceous marl; both occur not unfrequently in strata several feet in thickness. Conchiferous earth (conchiferous mould), consists only of the shells of conchifers still living in the bays of Finland and Bothnia, as for, example, *Mytilus edulis, Tellina balthica, Cardium edule, Paludinella stagnalis,* &c. These are met with most frequently on the coasts, as at Helsingfors, Ingo, Töfsala, Korpo, Nädendal, on Aland, in Wöro, &c.; and even in the interior of the country it is said that a thick layer of them has been met with at Jyväskylä, the species of which have not, however, as yet been investigated. If it should appear that the conchiferous mould there also consists of sea shells, we must infer that at the commencement of the alluvial period Päijäne was connected with either the Gulf of Bothnia or of Finland; in any other case the conchiferous mould in question consists of a fresh water formation, which has not before been observed in Finland.

The siliceous marl consists almost exclusively of siliceous coverings of *infusoria,* which, for the greater part, are still met with in the rivers of Finland. It forms, for example, in Kalvola, Hvittis, Pudasjärvi, Kuusamo, &c., thick layers, and has in famine years been baked with meal into bread, which has served the inhabitants as food, although analysis has shown that it contains but a very small portion of organic matter.

Among Finland's alluvial productions ought also to be reckoned the lake and bog iron ores, which are certainly scattered over the whole land, but are met with principally in Osterbotten, Savolaks, and Karelen, and afford material for a remunerative trade in iron. They owe their origin to the magnetic and ordinary pyrites often occurring in our mountains, which, weathering in the atmospheric air, are carried away, partly dissolved, partly in a state of mechanical subdivision, by the rain and snow water to the bottom of the lakes and bogs. What causes the several forms under which the lake ores occur, as "hailstone," "gunpowder," and "nummular" ores, &c.; and also why the south-western part of the country, whose hills are by no means deficient in sulphuret of iron, cannot exhibit the same amount of such lake and bog ores, are all as yet unsolved questions. If we take the map of Finland and draw a right line from Borga to Brahestad, the ore-bearing lakes, whose number, according to the official list of licenses, amounts to more than 1000, are all east of this line, while, on the contrary, the country west of the same can only exceptionally exhibit any metalliferous lake; the fields of bog iron ore, which are usually dried up lakes, are equally rare. As there is no reason to suppose that precisely the mountains in northern and eastern Finland should contain a larger amount of sulphuret of iron than those in the south and west, it seems rational to suspect that other still unknown agents co-operate in the formation of the lake ores; the elucidation of this we must defer to a future time. That the lake ores are renewed, and consequently properly belong to the present period of earth formation, is a demonstrable fact; but their re-formation requires a longer space of time than is sometimes stated. No reliable observations have as yet been made on this point.

If we now, in conclusion, cast a general glance over the geological structure of Finland, we shall find that its principal mass is formed of varieties of granite and syenite, of varying texture and appearance. These minerals occur almost everywhere through the country, even in regions distinguished by other mineral formations, as for example, forms of slate, rapakivi, &c. To draw a boundary between the two is, with our present knowledge of the country, impossible.

The case is quite different with the slaty minerals. Although all these also are met with more or less scattered through the land, geologists have been able to define certain regions where they occur with more frequence and predominance. Thus, for example, a slaty region begins in the parish of Kalvola, in the district of Tavastehus, and extends in a western direction, over Birkala to Björneborg. From the last-named place another such region extends in a southern and south-eastern direction, into the district of Nyland.—On the northern shore of Ladoga another slaty region occupies the parishes of Imbilaks, Sordavala, Suistamo, Pelkjärvi, and the southern part of Tohmajärvi. In Kuusamo, lastly, a belt of slaty minerals, with tolerably definite boundaries, extends from Paanajärvi in a south-western direction to Kitkajärvi; and in Kemi, as also in many other places, slaty hills are predominant.

The slaty minerals in Finland are represented by gneiss, clay slate, mica slate, hornblende slate, talc slate, and chlorite slate, and as to quantity occur in about the order in which we have enumerated them. We must here observe that the gneiss is not always, and is even very rarely, actual gneiss, if we assign to this mineral an aqueous origin. We have, so far as our own experience has permitted it, changed the denomination gneiss, employed by several authors, for that of gneissose granite, understanding thereby a Plutonic mineral (granite), whose mica-laminæ have occasionally assumed a slaty (gneiss-like) position towards each other, but have soon scattered again. By actual gneiss we understand only the mineral which, composed of the same constituents which enter into granite, with a definite slaty texture, extends over larger ranges, as is, for example, the case with the gneiss on the northern shore of Ladoga, the east shore of Botby Bay, in Nyland, &c.

The mineral rapakivi,* peculiar to Finland in its mode of weathering, which, in a geological point of view, forms a connecting link between granite and porphyry, occupies in southern Finland a region, whose boundaries can be, with tolerable accuracy, defined. It begins between Perno church and Louisa town, and extends eastward to the river Wuoksen. In the north the district seems to be bounded by the branch of Maanselkä, which extends through the parishes Walkiala and Luumäki. Rapakivi occurs also in other districts of Finland, but

* In place of the Finnish name *rapakivi*, the more scientific term *sapro-orite*, compounded of the Greek words *σάπρος* (rotten), and *ὄρος* (mountain), has been proposed.

it has not been everywhere so accurately investigated as to enable its boundaries to be definitely stated. Thus, for example, a great part of the so-called terra firma of Aland consists of this species of rock; in the district of Abo it forms a predominant mineral in the parishes of Letala, Sastmola, Eura and Euraaminne, and occurs finally in Rautalampi parish, in the district of Kuopio, and in Pieksämäki, parish of St. Michael's district, as a subordinate rock. Of rapakivi, two varieties may be observed—the one readily weathering, the other longer resisting the influence of the atmosphere. In both, nodules of felspar occur surrounded with oligoclase. The more readily weathering variety seems properly to be general in the region described as the southern part of Finland. Generally speaking, the property of weathering has been attributed to the oligoclase; but as we now know that oligoclase enters into the less readily weathering variety of rapakivi, another still unknown cause must be sought for the weathering in question. An accurate examination of this mineral would be particularly desirable, and in such case I should recommend the western part of Aland, where at the same time, moreover, the several points of contact between granite, rapakivi, and porphyry, could be investigated.

Another mineral occurring in Finland to an important extent, is quartz. It is met with under many different structural relations, and is tolerably widely diffused. The mountains of Lapland consist for the most part of quartz; and a belt thereof can be defined, taking its rise in Lapland, and extending in a south-eastern direction through the whole land into the Olonetzskian government of Russia, after having first formed the highest mountain tops in Paltamo and Sotkamo, and appeared with Pisavuori (in Nilsia), Suppuravaara (in Enontaipale), Watalavaara (in Tohmajärvi), and Walkiavaara (on the boundary between Ilomants and Suojärvi). If we take into account only the constituents, without attending to the origin of the minerals, sandstone also will be included in the quartz group. Such is in Finland met with only in the parishes of Säkylä and Lappfjärd, where it is dug up in great slabs, but it has not yet been ascertained whether these occur in a fixed vein under the diluvial earth, or only in loose portions mingled in the same. On the southern coast of Finland, in the district of Abo, loose pieces and slabs of a ruddy sandstone are not uncommon.

As has already been mentioned, the western boundary of the lake-ore region is formed by a line drawn from Borgä to Brahestad. It is remarkable, that precisely where the lake-ore region ends, the district of the magnetic iron ores begins, and subsequently occupies the whole of the southern coast, extending 5 or 6 miles [about 32·5 to 39 English miles] in breadth, as far as Aland. It is true that layers of iron ore occur also exceptionally in one part or other of the land, for example, in Hvittis, Storkyro, Ofver-Torneä, &c., but in that case, always as isolated masses. The kind of stone in which the Finnish magnetic ores occur is usually diorite, or some rock allied thereto. Consequently, diorite, which is, it is true, met with also in isolated masses in other parts of the country, has its greatest extent in the region of the magnetic ores.

With the last-named region, that of limestone coincides. According to our experience Finland exhibits only crystalline and close-grained limestones, which belong to the primary formation; and I can assent neither to the views of those who, in the crystalline limestone of Finland, are inclined to see metamorphic Silurian layers, in which every trace of organic life was destroyed by fire, nor to the assertions of those who, labouring under self-deception, pretend that they have found fossils in the crystalline limestone from Henriksnäs, in the neighbourhood of Kuopio. The limestone of southern Finland is distinguished for containing many interesting minerals, which, particularly in the coarsely crystalline limestone, occur better and more regularly crystallized. Of much more limited extent than is above mentioned, a region of close dolomitic limestone is met with on the northern shore of Ladoga.

Many of the minerals of the country occur porphyritic, as for example, granite, diorite, &c., but natural porphyry occurs also in Aland and Hogland.

As subordinate minerals, Finland reckons copper ore, hornblende rock, augite rock, serpentine rock, siliceous schist, trap, &c. Of the last-named it is to be observed that it is always met with in dykes, and principally in Abo district and in the Archipelago of Aland.

VII.—Report of Council for the Year 1862–3.

[Read at the Anniversary Meeting, on Wednesday, February 11, 1863.]

At the commencement of this, their thirty-second session, the Council have to congratulate the members on the satisfactory condition of the Society, as evinced by the increase of eight in the number of members.

They have to deplore the loss, by death, of three of our body; one of whom was among the number, which is now, after the lapse of thirty-one years, becoming very small, of their original members.

The Rev. Dr. Wall was well known to all who were even remotely connected with the University of which he was so long a distinguished ornament, and who remember the enthusiasm with which his attainment of the fiftieth anniversary of his election to a Fellowship in Trinity College was celebrated a few years ago. He had never taken a very active part in the proceedings of the Society, as his talents, during the later years of his life, were exclusively devoted to the study of the Oriental Languages, of which he had held the professorship for a period of twenty-three years, from 1824 up to his election to the Vice-Provostship in 1847. His zeal and assiduity in his favourite study are proved by the elaborate work which he published under the title of "An Examination of the Ancient Orthography of the Jews, and the original state of the text of the Hebrew Bible." The importance of accurate investigations in this direction can hardly be overstated at a period when the attention of the public has been especially directed to this subject.

Dr. Wall was a most munificent benefactor to the College, as, in addition to valuable donations to the Library, he founded five scholarships for the encouragement of Shemitic learning.

Archdeacon Verschoyle, the news of whose death was received a day or two before the last anniversary meeting, was also an old member although not one of the original founders of the Society. He joined it in the year 1834, and read three papers at its meetings, entitled, respectively:—

1. "On an instrument denominated by him an Orthoscope."
2. "On the contact of Mica Slate and Limestone at the Rosses, near Sligo."
3. "On some Globular Concretions in Sandstone."

His most important geological paper was one which is published in the Transactions of the Geological Society, London, vol. V. (2nd series), "On the Dykes of the North Coast of Mayo," on which subject he had already read a paper at the meeting of the British Association in this city in 1834. One of these dykes he succeeded in tracing for a distance of sixty miles across the country, and another for upwards of forty.

In addition to these papers, he evinced his interest in geology by his researches into the mineralogy of the west of Connaught, in which he succeeded in discovering several rare minerals, among which kyanite and scapolite may be mentioned.

Lastly, we have to lament the loss of the Marquis of Lansdowne, who has been so recently taken away from us. He had been a member of the Society for twenty-three years, and was descended from one who was among the first to develope the mineral resources of Ireland, Sir William Petty.

In consequence of a recent resolution of the Council, by which the delivery of a presidential address is left optional with that officer, the duty of reviewing the questions which have engaged the attention of the Society during the past session devolves on the Council.

The papers which have been read have for the most part referred to subjects connected with physical and descriptive geology. In fact, with the exception of the exhibition at the meeting in April, by Dr. Carte, of a magnificent specimen of the head and horns of the barren-ground variety of the American Reindeer, the history of organic life on the globe has not been brought prominently before our notice. The specimen in question is in the Museum of the Royal Dublin Society, and was discovered near Ashbourne, in this county. It is in a beautiful state of preservation, and, as was observed by Dr. Carte, its discovery points to conditions of climate and of the relations of land and water very different from those which now exist, when it, which is now a denizen of the extreme north of America, was able to exist in this country. It is very remarkable that this variety of Reindeer has not been found fossil in any part of Europe except Ireland, as all the specimens which have been found in Great Britain belong to the European variety. That the find-

ing of a pair of antlers with the peculiar brow-snag so characteristic of this species is not a mere accidental occurrence, is proved by the fact that all the specimens of the *Tarandus rangifer* which have been found fossil in Ireland, exhibit it; e. g. the fine head found many years ago near Kiltiernan by Dr. Moss, a description of which, by our former President, Professor Oldham, is contained in the 3rd volume of our "Journal."

The critical part of geology has been represented by a long and elaborate paper "On the five Palæozoic Red Sandstones," which was read by Mr. Kelly, at the June meeting. This communication evinced the care in compilation, and the accuracy of topographical knowledge, for which its author is so deservedly remarkable. The Council regret that the extra expense incurred by them in issuing the whole of vol. ix. of the "Journal" in the space of two years has prevented their being able to print Mr. Kelly's paper in full. In it he opened up the whole question of the nomenclature of the Palæozoic rocks, maintaining the right of the term "Old Red Sandstone" to stand for the lowest beds of the Carboniferous period, and for no others. He brought forward copious evidence to prove the differences in geological age, and relations to the adjacent strata which exist between the five Sandstones to which his paper referred, and which he states have all of them indiscriminately received the name of Old Red Sandstone. This confusion has been worst in Scotland. The first four of the Sandstones were included in the group of rocks formerly called Grauwacke, out of which the modern Silurian and Devonian systems have been formed. We shall describe these Sandstones in Mr. Kelly's own words:—

"1. The first is the primary Red Sandstone of Sutherland, at Coulmore, 2,500 feet thick—then 7,500 feet of mica slate, quartz rock, and primary limestone alternating; then the Cambrian rocks, 51,000 feet thick, making 58,750 feet between the first and second Red Sandstones. 2. The second is seen at the base of the Silurian rocks at Glencraff, Maume, Boocaun, and Kilbride, in Connemara, 400 feet thick, between Killery harbour and Lough Corrib. From the second to the third bands includes the whole of the lower and upper Silurian systems, making about 28,000 feet thick. 3. The third Red Sandstone is the Devonian, and from the base of this to the top is about 40,000 feet, as seen in North Devon—the red part below being interstratified with green and gray grits and slates for more than three-fourths of this thickness. 4. The Old Red Sandstone, lying unconformably on all the supporting rocks of every kind—this is the basal band of the Carboniferous rocks, is about 1,000 feet thick, and the whole formation in some places (South Wales) 11,000 feet. 5. A fifth Red Sandstone, the New Red, lying unconformably on the coal series, recently called Permian."

One of Mr. Kelly's remarks is one in which most geologists will agree with him, whether they admit all his conclusions or not. It runs as follows:—

"One of the greatest evils in the study of natural science is the alteration of names during its progress. There is some excuse for chang-

ing the names of fossils, of which it is often difficult in the beginning to get good specimens, but none for altering the name of a zone of rock."

Physical geology has been represented by two communications. One of these was a letter giving an account of the fall of a meteorite at Dhurmsalla, in the Punjaub, a specimen of which was presented to the Society at the March meeting. The other was a paper by Mr. Jukes, "On the mode of formation of some of the River Valleys of the South of Ireland."

The account of the meteorite possessed one feature of peculiar interest—that the fragments of the stone, though incandescent when seen to fall, were so *cold* when picked up immediately afterwards, that the finders could not hold them in their hands.

At the meeting in May Mr. Jukes laid before the Society his views on the mode of formation of some river valleys, a paper which he afterwards read before the Geological Society of London, and which has been printed in their "Journal." The author first alluded to the structure of the central limestone basin of Ireland, the level of the watersheds of which does not exceed 300 feet above the sea, while the rivers which drain it flow through ravines of considerable depth cut across older Palæozoic rocks of a much harder nature than the limestone. He took the simple cases of the Bandon, the Lee, and the Blackwater, each of which, after flowing for some distance in an east and west course—a direction coincident with that of the lines of elevation of the country and the strike of the beds—turn to the southward, and flow through deep ravines to the sea.

For the solution of this problem he proposed to assign a reason for the formation of these ravines, which are cut at right angles to the existing lines of hills of the district, rejecting the theory of their having been produced by disturbance, and attributing them instead to the action of the atmosphere.

As the basis of his explanation he lays down the following principles, which are undoubtedly sound :—

I. Denudation is of two kinds, marine and atmospheric.

II. Marine denudation is effective only about the sea level, and along the margin of the land. It acts with a broad horizontal movement, tending to plane down the land to its own level. If the land be long stationary, it produces long vertical cliffs about its margin; if the land rise slowly and equally, it forms gentle slopes upon it.

III. Marine denudation cannot produce ravines or narrow winding valleys, except as gaps or passes upon the crests of ranges of hills where the neighbouring summits were islands, and the present gaps or passes were "sounds" or "straits" between them, traversed by strong tides and currents, and a narrow arm of the sea was thus made to assume a river-like action.

IV. Atmospheric denudation acts vertically, either by the weathering and disintegration of rock over the whole surface of land, or by the vertical cutting and grooving of ice in glaciers, and of running water in rills, brooks, and rivers.

According to Mr. Jukes, the key to the change of direction of the three river valleys alluded to is to be found in some important tributaries which these rivers receive at or near the point of flexure, as, for instance, the two streams which join the Blackwater near Cappoquin.

In his opinion the lower part of the valley of the Blackwater is to be considered more as the valley of these north and south streams than as that of the Blackwater itself, and the relations are precisely similar in the cases of the two other rivers which have been named. Mr. Jukes considers these ravines to have taken their origin at a period long anterior to the present condition of the country, when the surface of the central area of Ireland stood at a level much higher than that which it now has. At this period the prevalent direction of the streams was from north to south—from the dominant ridges to the sea, and they then commenced to cut ravines. Some of the streams, being more powerful than others, succeeded better in keeping their channels open than their competitors, which accordingly flowed along the strike of the beds until they found an outlet to the sea. In this way the tributary streams just mentioned may be considered to have intercepted the rivers in their ordinary course, and diverted their channels into their present form. In the case of the Blackwater, the present channel from Cappoquin to Youghal is fifteen miles long, while the direct line along the strike to the sea at Dungarvan is only ten miles in length.

It is evident that such an explanation as this is at once applicable to the solution of the similar problems in the case of the larger rivers, such as the Shannon, the Barrow, Nore, and Suir. A remarkable confirmation of the tendency of atmospherical denudation to wear down limestone vertically is to be seen in the district of Burren, in Clare, where the limestone is exposed over an extensive area. Here in many places it has wasted away like the ice of a glacier. Mr. Jukes reminds those who may object to the length of time necessary for such an extensive atmospherical action, that if we except the brief interval of the glacial period when the submergence of all the land in high latitudes was almost universal, the whole of Leinster, Munster, and Connaught, with a large portion of Ulster, has been exposed to the action of the rain and air ever since the commencement of the Permian period.

At the same meeting of the Geological Society of London a paper was read by our President "On the Granites of Donegal," being Part III. of his "Experimental Researches on the Granites of Ireland." The former parts of his researches have already appeared in the earlier numbers of that Journal. In this paper he enters into an elaborate discussion, in the first place, of the systems of joints which traverse the country; and, in the second, of the chemical and mineralogical composition of the granite itself, based on accurate analyses of the rock itself and of its constituent minerals.

He gives at the close of the paper a new method of investigation of the percentage mineralogical composition of a granite containing four constituents, viz.:—Quartz, Orthoclase, Oligoclase, and Black Mica, and arrives at the following result for the percentage composition of the

granite of the Guibarra Valley, which may be taken to be the typical rock of the county:—

Quartz,	30·63
Orthoclase,	24·33
Oligoclase,	41·88
Black Mica,	3·16
	100·00

At the December meeting, the granites of Donegal were again brought before our notice by one of our Honorary Secretaries, Mr. Scott, who read a paper on the subject in continuation of that read by him last year. In this paper he described the structure of the north of the county, where there is a great thickness of metamorphic rocks immediately overlying the granite. He expressed his opinion that these rocks would be found to be the equivalents of the Huronian series of Canada, and of the analogous rocks in Norway, with which they agree as to their mineralogical and physical structure.

This paper led to a discussion, in which Mr. Jukes expressed his opinion that the Metamorphic rocks above alluded to were altered Silurians, and did not belong to the Huronian or Laurentian series at all.

With reference to this subject the Council are glad to announce that they have received a paper from Dr. T. Sterry Hunt, F.R.S., of the Geological Survey of Canada. This paper had been promised at an earlier period, and had been delayed in consequence of Dr. Hunt's severe illness. It will be read at the next meeting. In it he discusses the question of Metamorphism in general, and of the weight which may be attached to chemical constitution as affording evidence for the identification of strata.

Two other papers on granites were laid before us, which, however, did not enter at all so deeply into the question as those just mentioned. These were the President's account of his tour on the shores of the Baltic, which was performed last summer; and a paper by Professor Holmberg, of Helsingfors, on the geological structure of Finland.

The past year has been unusually prolific in papers on foreign geology. In April, Mr. Kingsmill, one of our members, sent us an extremely interesting preliminary paper on the Geology of the South and East coasts of China, which contained several highly important facts, and which, it is to be hoped, is only the prelude to future communications from the same pen on this hitherto almost untouched subject.

In June, Captain Meadows Taylor laid before us his views on the geology of Shorapoor, in the Dekhan, which district has formerly been included by geologists in the great granite field of Southern India. Captain Taylor shows the error of this view by explaining the true structure of the district, which is composed of limestone, trap, &c., in addition to granite.

The paper was illustrated by a series of admirable sketches of granitic pillars, which have assumed the most fantastic shapes, and afford

evidence of the extent to which so hard a rock as granite may be worn away by atmospherical action in tropical climates.

The stratigraphic geology of Ireland was represented by two papers—one by Messrs. Denny and Townsend, "On a Section across the Valley of Tralee;" and the other by Mr. A. B. Wynne, "On the Geology of parts of Sligo." The Council cannot but regret that the last-named gentleman has left them, having exchanged his position on the Geological Survey in this country for a post in the Geological Survey of India. The Society will miss the admirable sketches with which he was accustomed to illustrate the papers which he brought under their notice; and can only hope that he, like Mr. Kingsmill, will at times send them some news of the geology of his new home.

The practical and economical results of geology, as represented by mining, were brought before the Society on several occasions. The March meeting was almost exclusively taken up with this subject, as we had two communications on gold mining—one from Mr. Baily, "On the Tuapeka Gold Field, New Zealand;" and the other from the Rev. Mr. Storrs, qualifying the statements made by him in his former letter on the Gold Fields of Nova Scotia, which has already appeared in your "Journal." At the same meeting the President made a few remarks on the iron ores, &c., of Kilbride, county of Wicklow.

At the April meeting, Mr. Bolton read a short paper on the occurrence of manganese ore near Dublin; and a brief note from Mr. Emerson J. Reynolds, relative to the discovery of nickel in mica slate at Curraun-Achill, county Mayo, derived additional interest from its having attracted the attention of Mr. Mallet, who sent us a letter, containing his views on the probable existence of nickel in quantity in the west of Ireland.

Lastly, a paper by Mr. Jukes, "On the Occurrence of the Electric Calamine at the Silver Mines, county of Tipperary," was sent in at the June meeting, but, owing to the lateness of the hour, was only laid on the table. The author explained his views as to the formation of the calamine, which occurs irregularly in the bedding of the adjacent rock, by a double decomposition between the material of the limestone and the products of oxidation of the contents of the lode, taking place in presence of water which contained silica. These facts show that the deposit cannot be worked as an ordinary mine.

Your Council cannot conclude their report without noticing briefly a work recently published by Mr. Robert Mallet, formerly President of this Society, and who was accustomed, when resident in Dublin, to take a very active part in the proceedings of its meetings. This work is the account of the Great Neapolitan Earthquake of 1857, recently published in two volumes by Mr. Robert Mallet. It may be truly said to be the first really scientific account of an earthquake, in which the phenomena are described in accordance with accurate mechanical and physical principles. The theory of earthquake phenomena has engaged the attention of Mr. Mallet for many years, and he has recently received the gold medal of the Royal Irish Academy, in testimony of his services rendered

to this branch of science; and he now enjoys the privilege, which is granted to but few discoverers, of applying to practice the theory he has himself invented. The late earthquake in the South of Italy occurred in December, 1857; and in the course of the same month Mr. Mallet volunteered, if supported by the aid of the Royal Society of London, to visit the seat of the earthquake, and collect materials, of a positive kind, by which he should be enabled to describe it with the precision which the present state of geological science imperatively demands. The Royal Society liberally aided him, both in his expedition, and in the publication of the results of his investigation;—and the fruits of his labour are now fully before the public.

Mr. Mallet has divided his work into three parts; in the first of which he proposes generally the questions for solution, and the methods of investigation employed; the second contains a narrative of the observations actually made, and the information obtained; and in the third part the results are classified, and such conclusions are drawn from them as they appear to warrant. The following important results are obtained from a discussion of the whole:—

1. With regard to the form of the surface of the country disturbed, it is shown to be ovoid, with the centre, or rather centres, of shock, occupying a transverse line, situated near the small extremity of the ovoid.

2. The mean depth along this transverse line, from which the shock proceeded, is found to be $5\frac{3}{4}$ geographical miles, or 34,930 feet, which may be regarded as the depth of the focus; and the probable vertical dimension of the focal cavity itself does not exceed 3 geographical miles, or 18,225 feet at the outside; and as the horizontal extent, in a N. E. and S. W. direction of the transverse line of shock centres does not exceed 9 miles at the surface, we may imagine the earthquake focus to occupy a somewhat plane area, of elliptical form, whose vertical axis is 3 miles, and horizontal axis 9 miles, the depth of the centre of this elliptical focus being $5\frac{3}{4}$ miles below the sea level.

3. With regard to the earthquake vibration itself, Mr. Mallet arrives at the conclusions, that its velocity was 12·093 feet per second, and that its amplitude did not exceed 3 or 4 inches; of these two conclusions, the first is based upon very solid mechanical considerations, derived from the fracture, overthrow, and projection, of various objects and buildings, and may justly be regarded as one of the most important results to which Mr. Mallet's investigation has led.

4. The velocity of the earthquake wave varied from 700 feet to 1,000 feet per second, according to the geographical structure of the country through which the wave of shock passed.

5. Lastly, Mr. Mallet has proved that the refraction and reflexion of an earthquake wave is a reality observable in the field, though first predicted by mathematicians in the closet. This important fact is fully established by the proof which he gives, that the shock that reached

Naples was the earthquake wave refracted by the range of the Monte St. Angelo, to the South of the Bay of Naples.

We congratulate the Society on the circumstance, that so important an addition to physical geology as Mr. Mallet's book will prove itself to be, has been given to the world by one who first learned the principles of our science in the Geological Society of Dublin, and who occupies so distinguished a place among its members.

As regards the financial position of the Society, the Treasurer's report for the year 1862 is favourable, as the amount received for annual subscriptions is slightly in excess of what it has been in previous years. The total amount which has been received from all sources is £125 1*s.* 4*d.*, and the expenditure within the year has been £137 1*s.* 2*d.* It will be remembered that there was a balance in hands at the commencement of the year which amounted to £28 4*s.*, so that the Treasurer has been enabled to meet the deficiency in this year's accounts, and leave a balance in favour of the Society for the next year of £16 4*s.* 1*d.* The chief item of expenditure is the cost of publishing the "Journal," which has been unusually high this year, amounting to £70; and though £26 5*s.* 3*d.* of this sum was a balance due for 1861, we must still consider the expense of publication in 1862 to have been much above the average, as there is a balance now due for that year.

In the Appendix will be found, as usual,

I. A list of all the members now on the books of the Society.
II. A list of the members gained and lost during the year.
III. A list of donations received during the year.
IV. A list of the Societies and Institutions to whom a copy of our "Journal" is regularly forwarded.
V. An abstract of the Treasurer's accounts for the year 1862.

Note.—Since the above Report was written, the Council have the painful duty of announcing the death of one of their most valued members, Professor J. R. Kinahan, M.D., &c. Although his talents were chiefly devoted to the investigation of the natural history of existing organisms, yet in the papers read before this Society, and the Royal Irish Academy, in which he developed the Palæontology of the Cambrian rocks in the neighbourhood of Dublin, he gave an earnest of what he could have done had he devoted himself exclusively to geological researches.

APPENDIX TO ANNUAL REPORT.

No. I.

LIST OF MEMBERS, CORRECTED TO JANUARY 31, 1863.

Members are requested to correct errors in this List, by letter to the REV. SAMUEL HAUGHTON, *Trinity College, Dublin.*

OFFICERS OF THE SOCIETY FOR THE YEAR 1863–4.

PRESIDENT.—Rev. H. Lloyd, D. D., F. R. S., Vice-Provost.

VICE-PRESIDENTS.—James Apjohn, M. D., F. R. S.; Lord Talbot de Malahide, F. R. S.; Robert Calwell, Esq.; Joseph Beete Jukes, M. A., F. R. S.; Rev. S. Haughton, M. D., F. R. S., F. T. C. D.

TREASURERS.—Gilbert Sanders, Esq,; F. J. Sidney, LL. D.

SECRETARIES.—Robert H. Scott, M. A.; Robert S. Reeves, M. A.

COUNCIL.—Sir Richard Griffith, Bart., LL. D., F. G. S.; John Kelly, Esq.; John B. Doyle, Esq.; G. MacDowell, M. A., F. T. C. D.; Alexander Carte, M. D.; W. H. Baily, F. G. S.; Alphonse Gages, M. R. I. A.; Rev. Joseph A. Galbraith, F. T. C. D.; William Andrews, Esq.; Edward Perceval Wright, M. A., M. D., F. L. Z. SS.; B. B. Stoney, C. E.; John Barker, M. B.; Samuel Downing, LL. D.; John Good, Esq.; W. B. Brownrigg, Esq.; with the Honorary Officers.

HONORARY MEMBERS.

Elected.
1844. 1. Boué, M. Ami, For. Mem., L. G. S., *Paris.*
1861. 2. Daubree, M., Membre de l'Institute, 91, *Rue de Greville, St. Germains, Paris.*
1861. 3. Delesse, M., Ingenieur des Mines, *Paris.*
1861. 4. De Serres, M. Marcel, *Montpelier.*
1861. 5. Deville, M. Charles, *Paris.*
1861. 6. Deville, M. Ste Claire, *Paris.*
1861. 7. De Koninck, M. L., For. Mem., L. G. S., *Liege.*
1861. 8. Geinitz, M. H. B., For. Mem., L. G. S., *Dresden.*
1844. 9. Lyell, Sir Charles, F. R. S., 53, *Harley-street, W., London.*
1861. 10. M'Clintock, Sir Leopold, R. N., 21, *Merrion-square, North.*
1844. 11. Murchison, Sir Roderick I., F. R. S., 16, *Belgrave-square, London, S. W.*
1832. 12. Sedgwick, Rev. A., F. R. S., *Cambridge.*

HONORARY CORRESPONDING MEMBERS.

1859. 1. Gordon, John, C. E., *India.*
1859. 2. Hargrave, Henry J. B., C. E., *India.*
1859. 3. Hime, John, C. E., *Ceylon.*
1858. 4. Kingsmill, Thomas W., *Hong Kong.*
1855. 5. Medlicott, Joseph, *India.*
1854. 6. Oldham, Thomas, F. R. S., *India.*

MEMBERS WHO HAVE PAID LIFE COMPOSITION.

1858. 1. Allen, Richard Purdy, 10, *Besboro'-terrace, N. C. Road.*
1861. 2. Armstrong, Andrew, *Claddagh, Bray.*
1861. 3. Brown, Markham, *Connorree Mines, Ovoca.*
1857. 4. Carson, Rev. Joseph, D. D., F. T. C. D., *Trinity College.*
1861. 5. Connolly, J., *Kilmore, Artane.*
1832. 6. Davis, Charles, M. D., 33, *York-street.*
1857. 7. Dowse, Richard, *Mountjoy-square.*
1861. 8. Fottrell, Edward, 86, *Harcourt-street.*
1862. 9. Frazer, W., M. D., 124, *Stephen's-green.*

Elected.
1857. 10. Greene, John Ball, 6, *Ely-place.*
1857. 11. Haliday, A. H., A. M., F. L. S., M. R. I. A., *Harcourt-street.*
1831. 12. Hamilton, Sir W. R., *Observatory, Dunsink.*
1848. 13. Haughton, Rev. Professor, M. D., F. R. S., 40, *Trinity College.*
1862. 14. Henry, F. H., *Lodge Park, Straffan, Co. Kildare.*
1850. 15. Hone, Nathaniel, M. R. I. A., *St. Doulough's, Co. Dublin.*
1861. 16. Hone, Thomas, *Yapton, Monkstown.*
1831. 17. Hutton, Robert, F. G. S., *Putney Park, London.*
1851. 18. Jukes, Joseph Beete, F. R. S., 51, *Stephen's-green.*
1834. 19. King, Hon. James, M. R. I. A., *Mitchelstown.*
1856. 20. Lentaigne, John, M. D., *Great Denmark-street.*
1848. 21. Luby, Rev. Thomas, D. D., F. T. C. D., *Trinity College.*
1851. 22. Malahide, Lord Talbot de, F. R. S., *Malahide Court, Malahide.*
1838. 23. Mallet, Robert, C. E., F. R. S., 1, *The Grove, Clapham-road, London.*
1846. 24. Murray, B. B., 6, *Martello-avenue, Kingstown.*
1859. 25. Ogilby, William, F. G. S., *Liscleen, Dunmanagh, Co. Tyrone.*
1849. 26. Sidney, F. J., LL. D., 19, *Herbert-street.*
1851. 27. Whitty, John Irvine, LL. D., 2, *Frederick-street, S.*

MEMBERS WHO HAVE PAID HALF LIFE COMPOSITION.

1831. 1. Baillie, Rev. James Kennedy, D. D., *Ardtrea, Stewartstown.*
1854. 2. Barnes, Edward, *Ballymurtagh, Co. Wicklow.*
1832. 3. Bryce, James, LL. D., F. G. S., *High School, Glasgow.*
1861. 4. Busteed, Dr., *Castle Gregory, Tralee.*
1862. 5. Carter, T. S., *Wallington Park, Tilsworth.*
1855. 6. Clarke, Edward, M. D., 3, *Frankfort Buildings, Rathgar.*
1854. 7. Clemes, John, *Luganure Mine, Glendalough, Co. Wicklow.*
1857. 8. Crawford, Robert, C. E., *care of Messrs. Peto and Betts,* 9, *Great George's-street, Westminster.*
1861. 9. Crosbie, William, *Ardfert Abbey, Ardfert, Tralee.*
1861. 10. Dunally, Lord, *Kilboy, Nenagh.*
1856. 11. Du Noyer, G. V., M. R. I. A., 51, *Stephen's-green.*
1832. 12. Dunraven, Earl of, F. R. S., *Adare, Co. Limerick.*
1836. 13. Enniskillen, Earl of, F. R. S., M. R. I. A., *Florence Court, Enniskillen.*
1844. 14. Esmonde, Sir Thomas, Bart., M. R. I. A., *Johnstown Castle, Wexford.*
1854. 15. Foot, Frederick J., 51, *Stephen's-green.*
1853. 16. Harkness, Professor, F. R. S., *Queen's College, Cork.*
1856. 17. Haughton, Lieut. John, R. A., *St. Helena.*
1857. 18. Haughton, John Hancock, Esq., *Carlow.*
1861. 19. Harte, W., C. E., *Donegal.*
1850. 20. Head, Henry, M. D., *Lower Fitzwilliam-street.*
1858. 21. Hill, J., C. E., *Tullamore.*
1862. 22. Hudson, R., F. R. S., F. L. S., *Clapham Common, London.*
1840. 23. Jackson, James E., *Tulliderry, Blackwatertown.*
1839. 24. James, Sir H., Colonel, R.E., F.R.S., *Ordnance Survey Office, Southampton.*
1832. 25. Kearney, Thomas, *Pallasgreen, Co. Limerick.*
1857. 26. Keane, Marcus, *Beech Park, Ennis, Co. Clare.*
1835. 27. Kelly, John, 38, *Mountpleasant-square.*
1858. 28. Kinahan, George H., *St. Kilda, Sandycove, Dalkey.*
1862. 29. Kincaid, Joseph, Jun., C. E., *Leinster-street.*
1838. 30. Larcom, Sir Thomas, R. E., LL. D., F. R. S., *Phœnix Park.*
1858. 31. Leech, Lieut.-Colonel, R. E., 29, *Eaton-place, London.*
1840. 32. Lindsay, Henry L., C. E.,
1840. 33. Montgomery, James E., M. R. I. A.
1856. 34. Molony, C. P., Capt., 25th Regt., Madras N. I., *per Messrs. Grinlay and Co.,* 8, *Cornhill, London.*
1856. 35. Medlicott, Henry, F. G. S., *Roarkee, Bombay.*
1857. 36. M'Ivor, Rev. James, *Rectory, Moyle, Newtownstewart, Co. Tyrone.*
1845. 37. Neville, John, C. E., M. R. I, A., *Dundalk.*

Elected.
1852. 38. O'Kelly, Joseph, 51, *Stephen's-green.*
1844. 39. Palmerston, Viscount, K.G., G.C.B., F.R.S., 4, *Carlton Gardens, London.*
1832. 40. Portlock, Major-Gen., R. E., F. R. S., *Lota, Cross-avenue, Blackrock.*
1832. 41. Renny, Henry L., R. E., *Canada.*
1854. 42. Smyth, W. W., F. R. S., *Jermyn-street, London.*
1832. 43. Tighe, Right Hon. William, *Woodstock, Innistiogue.*
1858. 44. Webster, William B., 104, *Grafton-street.*
1861. 45. Whitney, C. J., *Rosscarberry, Cork.*
1846. 46. Willson, Walter, 51, *Stephen's-green.*
1854. 47. Wyley, Andrew, 51, *Stephen's-green.*
1857. 48. Wynne, Arthur B., F. G. S., 51, *Stephen's-green.*

ANNUAL MEMBERS.

1861. 1. Andrews, William, *The Hill, Monkstown.*
1831. 2. Apjohn, James, M. D., F. R. S., *South-hill House, Blackrock.*
1857. 3. Baily, W. H., F. G. S., 51, *Stephen's-green.*
1857. 4. Bandon, Earl of, *Castle Bernard, Bandon, Co. Cork.*
1859. 5. Barker, John, M. B., 64, *Waterloo-road.*
1861. 6. Barrington, C. E., *Fassaroe, Bray.*
1862. 7. Barrington, E., *Fassaroe, Bray.*
1855 8. Barton, H. M., 5, *Foster-place.*
1862. 9. Barton, F., 2, *Grattan-street.*
1859. 10. Battersby, Francis, M. D., *Warrington-place.*
1844. 11. Bective, Earl of, *Headfort, Kells.*
1862. 12. Bennett, E., M. B., 25, *Holles-street.*
1858. 13. Bermingham, J., *Millbrook, Tuam.*
1861. 14. Blake, E. H., *Farmer's Club, Sackville-street.*
1857. 15. Bolton, George, Jun., 6, *Ely-place.*
1861. 16. Bolton, H. E., *Fitzwilliam Lodge, Blackrock.*
1831. 17. Brady, Right Hon. Maziere, Chancellor, 26, *Upper Pembroke-street.*
1861. 18. Brownrigg, W. B., 18, *Adelaide-road.*
1840. 19. Callwell, Robert, M. R. I. A., 25, *Herbert-place.*
1857. 20. Carte, Alexander, A. M., M. D., F. L. S., *Royal Dublin Society.*
1862. 21. Close, Rev. Maxwell, *Newtownpark, Blackrock.*
1858. 22. Cotton, Charles P., C. E., *G. S. & W. R., Nenagh.*
1862. 23. Cousins, A. L., 55, *Lower Baggot-street.*
1834. 24. Croker, Charles P., M. D., 7, *Merrion-square, West.*
1846. 25. D'Arcy, Matthew, M. R. I. A., *Anchor Brewery, Usher-street.*
1849. 26. Downing, Samuel, C.E., LL. D., 6, *Trinity College.*
1832. 27. Dublin, The Archbishop of, *The Palace, Stephen's-green.*
1852. 28. Doyle, J. B., *Martello-terrace, Sandymount.*
1853. 29. De Vesci, Lord, *Abbeyleix House, Abbeyleix.*
1856. 30. Fleming, Lionel J., C. E., 2, *Henrietta-street.*
1857. 31. Frith, R. J., C. E., *Leinster-road, Rathmines.*
1858. 32. Gages, Alphonse, M. R. I. A., 51, *Stephen's-green.*
1849. 33. Galbraith, Rev. Joseph A., F. T. C. D., *Trinity College.*
1856. 34. Ganley, Patrick, 6, *Ely-place.*
1859. 35. Green, Murdock, 52, *Lower Sackville-street.*
1862. 36. Gribbon, C. P., 72, *Stephen's-green.*
1831. 37. Griffith, Sir R., Bart., LL. D., F. G. S., 2, *Fitzwilliam-place.*
1856. 38. Good, John, *City-quay.*
1857. 39. Hampton, Thomas, C. E., 6, *Ely-place.*
1848. 40. Harvey, Professor, M. D., F. R. S., 40, *Trinity College.*
1861. 41. Hone, Joseph, Jun., 35, *Lower Leeson-street.*
1861. 42. Hudson, A., M. D., *Merrion-square.*
1861. 43. Humphrey, H. T., *Woodview, Merrion-avenue.*
1861. 44. Hutton, E., M. D., 5, *Merrion-square.*
1834. 45. Hutton, Thomas, F. G. S., 116, *Summer-hill.*

Elected.
1852. 46. Jellett, Rev. Professor, F. T. C. D., M. R. I. A., 6, *Trinity College.*
1842. 47. Jennings, F. M., M. R. I. A., F. G. S., *Brown-street, Cork.*
1861. 48. Johnston, C. F., 9, *Eustace-street.*
1858. 49. Jones, William, C. E., 6, *Ely-place.*
1861. 50. Joy, R., 33, *Mountjoy-square.*
1862. 51. Kinahan, G., J. P., *Roebuck-hill, Dundrum.*
1856. 52. Kinahan, J. R., M. D., M. R. I. A., F. L. S., *St. Kilda, Sandycove, Dalkey.*
1861. 53. Lewis, W., C. E., 13, *Nelson-street.*
1861. 54. Lisabe, F., C. E., 42, *Sackville-street.*
1831. 55. Lloyd, Rev. Humphrey, D. D., F. R. S., Vice-Provost, 35, *Trinity College.*
1861. 56. Lyster, J., C. E., *Stillorgan Lodge, Stillorgan.*
1855. 57. M'Causland, Dominick, 12, *Fitzgibbon-street.*
1861. 58. M'Comas, A., 28, *Rathmines-road.*
1851. 59. M'Donnell, John, M. D., 4, *Gardiner's-row.*
1852. 60. Mac Donnell, Rev. Richard, D. D., Provost of Trinity College, *Provost's House, Trinity College.*
1837. 61. Mollan, John, M. D., 8, *Fitzwilliam-square, North.*
1851. 62. M'Dowell, George, F. T. C. D., 6, *Trinity College.*
1859. 63. Moore, Joseph Scott, *The Manor, Kilbride, Co. Dublin.*
1862. 64. Moore, Stephenson C., *Kenilworth-villa, Rathmines.*
1861. 65. Morris, T. B., *Oaklands, Sandymount.*
1831. 66. Nicholson, John, M. R. I A., *Balrath House, Kells.*
1856. 67. O'Brien, Octavius, 23, *Kildare-street.*
1832. 68. Patten, John, *Royal Dublin Society.*
1861. 69. Patterson, B. T., C. E., 206, *Gt. Brunswick-street.*
1848. 70. Petherick, John, F. G. S., *Surbiton, Kingston-on-Thames, Surrey.*
1857. 71. Porter, William, C. E., *Leinster Club, Leinster-street.*
1861. 72. Ryan, George, 32, *Frederick-street.*
1857. 73. Reeves, R. S., 22, *Upper Mount-street.*
1861. 74. Roberts, W. G., *Ballinapark, Ovoca.*
1862. 75. Rowan, D. J., C. E., *Dundalk.*
1852. 76. Smith, Robert, M. D., 63, *Eccles-street.*
1852. 77. Sanders, Gilbert, M. R. I. A., 2, *Foster-place.*
1854. 78. Scott, Robert H., A. M., 18, *Ranelagh-road.*
1857. 79. Stack, Rev. Thomas, F. T. C. D., *Trinity College.*
1862. 80. Still, Henry, C. E., F. G. S., 6, *Besboro'-terrace, Circular-road, N.*
1859. 81. Stokes, William, M. D., F. R. S., *Merrion-square.*
1861. 82. Stoney, Bindon, C. E., 89, *Waterloo-road.*
1857. 83. Tait, Alexander, C. E., *Queen's Elms, Belfast.*
1862. 84. Taylor, Captain Meadows, *Old-court, Harold's-cross.*
1862. 85. Trench, W. R., *University Club, Stephen's-green.*
1859. 86. Waldron, L., M. P., LL. D., *Ballybrack, Dalkey.*
1859. 87. Walker, William F., A. M., 9, *Trinity College.*
1859. 88. Wilde, W. R., F. R. C. S. I., 1, *Merrion-square.*
1851. 89. Wright, Edward, LL. D., M. R. I. A., *Floraville, Donnybrook.*
1853. 90. Wright, E. Perceval, M. D., A. M., F. L. Z. SS., *Museum, Trinity College.*

ASSOCIATES FOR THE YEAR.

1. Doyle, E., *Martello-terrace, Sandymount.*
2. Dickinson, J., *Mountjoy-place.*
3. Geoghegan, C., *Carysfort-terrace.*
4. Homan, C., 2, *Haddington-road.*
5. Knapp, W., *Belgrave-square, Monkstown.*
6. Ormsby, M. H., 16, *Fitzwilliam-square.*
7. Quilton, E. T., 25, *Leinster-road.*
8. Russell, J., *Glenageary-hill, Kingstown.*
9. Woodward, R. C., 27, *Trinity College.*
10. Wynne, W. H., 12, *Trinity College.*

No. II.

MEMBERS GAINED.

LIFE MEMBERS.

1. Frazer, W., M. D., 124, *Stephen's-green.*
2. Henry, F. H., *Lodge Park, Straffan, Co. Kildare.*

MEMBERS WHO HAVE PAID HALF LIFE COMPOSITION.

1. Carter, T. S., *Wallington Park, Tilsworth.*
2. Hudson, R., F.R.S., F.L.S., *Clapham Common, London.*
3. Kincaid, Joseph, Jun., C. E., *Leinster-street.*

ANNUAL MEMBERS.

1. Barrington, E., *Fassaroe, Bray*
2. Barton, F., 2, *Grattan-street.*
3. *Bennett, E., M. B., 25, *Holles-street.*
4. *Close, Rev. Maxwell, *Newtownpark, Blackrock.*
5. Cousins, A. L., 55, *Lower Baggot-street.*
6. Gribbon, C. P., 72, *Stephen's green.*
7. Kinahan, George, J. P., *Roebuck-hill, Dundrum.*
8. Moore, Stephenson C., *Kenilworth-villa, Rathmines.*
9. Rowan, D. J., *Merrion-avenue, Blackrock.*
10. Still, Henry, 6, *Besboro'-terrace, Circular-road, N.*
11. Taylor, Capt. Meadows, *Oldcourt, Harold's-cross.*
12. Trench, W. R., *University Club, Stephen's-green.*

MEMBERS LOST.

RESIGNED.

Annual Members.

1. Barton, John, *Stone House, Donnybrook.*
2. Dickinson, Sir D. J., *Mountjoy-place.*
3. Gillespie, W., 24, *Merrion-street.*
4. Gordon, Samuel, M. D., *Hume-street.*
5. Greene, F. W., *Dame-street.*
6. Welland, W. T., 48, *Upper Rutland-street.*

DECEASED.

1. Jacob, Arthur, Corresp. Member.
2. Lansdowne, Marquis of, *London.*
3. Verschoyle, Archdeacon, *Collooney.*
4. Wall, Rev. C. W., D. D., Vice-Provost, *Trinity College.*

State of the Society at the commencement of—

	Year 1862.	Year 1863.
Honorary Members,	12	12
Corresponding do.,	6	6
Life do.,	72	75
Annual do.,	86	90
	176	183

No. III.

DONATIONS RECEIVED TO JANUARY 31, 1863.

Amsterdam.—Verhandelingen der Kon. Akademie van Wetenschappen Part 9.

——— Medeelingen, Vols. XI, XII. Presented by the Academy.

Berlin.—Zeitschrift für die Gesammten Naturwissenschaften, 1861, 1862. Presented by the Editors.

——— Zeitschrift für Allgemeine Erdkunde, Nos. 101–110. Presented by the Geographical Society.

——— Zeitschrift der Deutschen Geologischen Gesellschaft, Vols XIII. and XIV., Parts 1 and 2. Presented by the Society.

Bologna.—Memorie, Vol. XI., Parts 1, 2, 3, 4. Presented by the Institute.

——— Rendiconto delle Sessione dell' Accademia delle Scienzi dell' Instituto. 1860, 1861. Presented by the Institute.

Boston.—Journal of the Boston Natural History Society, Vol. VIII., Sheets 5 to 20. Presented by the Society.

Brussels.—Annuaire de l'Academie Royale, 1862. Presented by the Academy.

——— Bulletin de l'Academie Royale, Nos. 11, 12. Presented by the Academy.

Calcutta.—Annual Report of the Geological Survey of India, 1860-1. Presented by Professor Oldham, Director.

——— Memoirs of the Geological Survey of India, Vol. III., Part 1. Presented by Professor Oldham.

——— Palæontographica Indica, Vol. I. Presented by Professor Oldham.

Canada.—The Canadian Journal of Industry, Science, and Art, Nos. 37 to 42. Presented by the Editors.

Cornwall.—Annual Report of the Royal Cornwall Polytechnic Society, 1861. Presented by the Society.

Dijon.—Memoires de l'Academie Impériale de Dijon, 1860–1. Presented by the Academy.

Dublin.—The Dublin Quarterly Journal of Science, Nos. 5 to 8. Presented by the Editor, Rev. S. Haughton, M. D.

——— Journal of the Royal Dublin Society, Nos. 24 to 28. Presented by the Society.

——— Proceedings of the Royal Irish Academy, Vol. VIII., Parts 1, 2. Presented by the Academy.

——— 11 Quarter Sheets of the Geological Survey of Ireland. Presented by Sir R. Murchison, Director-General.

——— Inventory Catalogue of the Rock Specimens in the Museum of Irish Industry. Presented by J. B. Jukes, Esq., Local Director of the Geological Survey.

——— Transactions of the Institute of Civil Engineers of Ireland, Vol. VII., Part 1. Presented by the Institute.

Edinburgh.—Transactions of the Scottish Society of Arts, Vol. VII., Part 2. Presented by the Society.

Glasgow.—Proceedings of the Philosophical Society, Vol. V., Part 2. Presented by the Society.

Kilkenny.—Proceedings and Papers of the Kilkenny and South-East of Ireland Archæological Society. Nos. 35 to 38.

Königsberg.—Schriften der Königlichen Physikalisch-Oekonomischen Gesellschaft, Vol. II., Parts 1 and 2. Presented by the Society.

Lausanne.—Bulletin de la Société Vaudoise des Sciences Naturelles, No. 49. Presented by the Society.

Leipsic.—Berichte über die Verhandlungen der Königlichen Sächsischen Gesellschaft der Wissenschaften, 1849-62. Presented by the Society.

——— Abhandlungen der Mathematisch-Physischen Classe 1852–61. Presented by the Society.

Liverpool.—Proceedings of the Literary and Philosophical Society, No. 16. Presented by the Society.

Liverpool.—Transactions of the Historic Society of Lancashire and Cheshire, Vol. I., New Series. Presented by the Society.

London.—Proceedings of the Institute of Civil Engineers, Vols. XIX., XX. Presented by the Institute.

——— Quarterly Journal of the Geological Society, Nos. 69 to 72. Presented by the Society.

——— Proceedings of the Royal Geographical Society, Vol. VI., Parts 2 to 5; Vol. VII., Part 1. Presented by the Society.

——— Journal of the Royal Geographical Society, Vol. XXXI. Presented by the Society.

——— Notices of the Proceedings of the Royal Institution of Great Britain, Part 12. Presented by the Institution.

——— Proceedings of the Royal Society, Nos. 46 to 52. Presented by the Society.

——— Report of the British Association, Manchester, 1861. Presented by the Association.

——— Proceedings of the Zoological Society, 1861, Parts 1, 2. Presented by the Society.

——— Journal of the Proceedings of the Linnean Society, Parts 22 to 24. Presented by the Society.

——— The Mining and Smelting Magazine, Nos. 11 to 13. Presented by the Editor.

Madrid.—Memorias de la Real Academia de Ciencias, Vols. III., IV., V. Presented by the Academy.

——— Resumen de las Actas 1848—60.

Manchester.—Transactions of the Manchester Geological Society, Vol. III., Nos. 10 to 15. Presented by the Society.

——— Memoirs of the Literary and Philosophical Society of Manchester, 1861–2. Presented by the Society.

——— Proceedings of the Literary and Philosophical Society of Manchester, Vol. II. Presented by the Society.

Milan.—Atti del Reale Instituto Lombardo de Scienze, Vol. II., Parts 1, 2, 3; Vol. III., Part 1. Presented by the Institute.

Montreal.—The Canadian Naturalist and Geologist, and Proceedings of the Natural History Society of Montreal, No. 6, and Vol. VII., Parts 1 to 6. Presented by the Society.

Munich.—Sitzungs-berichte der K. Baier. Akad. der Wissenschaften zu München, Parts 1, 2, 3, 4, 1862. Presented by the Royal Academy of Munich.

——— Abhandlungen der Math-Physik; Classe. Vol. IX., Parts 1, 2. Presented by the Royal Academy of Munich.

Neufchatel.—Bulletin de la Société des Sciences Naturelles, Vol. V. Presented by the Society.

Newhaven.—The American Journal of Science and Art, Nos. 97 to 102. Presented by the Editors.

Paris.—Annales des Mines, 16 vols. Presented by the Rev. Professor Haughton, M. D.

Philadelphia.—Proceedings of the Academy of Natural Sciences, pp. 155 to 556. Presented by the Academy.

——— Transactions of the American Philosophical Society. Presented by the Society.

Plymouth.—Annual Report of the Plymouth Institute, and Devon and Cornwall Natural History Society, 1861–2. Presented by the Society.

Presburg,—Verhandlungen des Vereins für Naturkunde, Vols. IV., V. Presented by the Association.

St. Petersburg.—Verhandlungen der Kaiserlichen Gesellschaft für die Gesammte Mineralogie, 1862. Presented by the Society.

Strasburg.—Memoires de la Société des Sciences Naturelles, Vol. V. Presented by the Society.

Vienna.—Jahrbuch der K. K. Geologischen Reichsanstalt, Vol. XII., Parts 1, 2, 3. Presented by the Editor.

Washington.—Results of Meteorological Observations made under the direction of the U. S. A. Patent Office and the Smithsonian Institute, from 1854 to 1859, Vol. I. Presented by the Institute.

Washington.—Report on the Geology on the State of Wisconsin, Vol. I. Presented by the Institute.
——— Report of the Geological Survey of Kentucky, Vol. IV. Presented by the Institute.
——— Annual Report of the Smithsonian Institute. Presented by the Institute.

PRESENTED BY THE AUTHORS.

Ashburton.—Address delivered at the Anniversary Meeting of the Royal Geographical Society, by Lord Ashburton, F. R. S.
Delesse.—Carte Geologique et Hydrologique de la Ville de Paris. By M. Delesse.
——— Recherches sur les Pseudomorphoses.
——— Recherches sur l'eau dans l'interieur de la terre.
Geinitz.—Darstellung des Flora des Hainichen-Ebersdorfer und des Floehaer Kohlen Bassins. By Prof. H. B. Geinitz.
——— Das Quadergebirge oder die Kreideformation in Sachsen mit besonderer Berücksichtigung der Glaukonit-reichen Schichten.
——— Erklärung der Abbildungen.
Haast.—Report of a Topographical and Geological Exploration of the Western District of the Nelson Province, New Zealand, By Julius Haast.
Hankel.—Messungen über die Absorption der Chemischen Strahlen des Sonnenlichtes. By W. G. Hankel.
——— Elektrische Untersuchungen.
Jukes.—Student's Manual of Geology, 2nd edition. By J. Beete Jukes, M. A.
Lloyd.—On Earth-currents, and their Connexion with the Diurnal Changes of the Horizontal Magnetic Needle. By Rev. H. Lloyd, D. D., President.
Sabine.—Report on the Repetition of the Magnetic Survey of England. By Major-General Sabine, F. R. S.
Marcou.—Letter on the Taconic Rocks of Vermont and Canada. By Jules Marcou.
Holmberg.—Bidrag till Finland's Naturkännedom. By Prof. H. V. Holmberg.

No. IV.

SOCIETIES AND INSTITUTIONS ENTITLED TO RECEIVE THE JOURNAL OF THE GEOLOGICAL SOCIETY OF DUBLIN.

ABERDEEN, .	University Library.
ALBANY, . .	State Library, New York.
AMSTERDAM, .	Royal Academy of Sciences.
BELFAST, . .	Queen's College Library.
BERLIN, . .	Royal Academy of Sciences.
	German Geographical Society.
	German Geological Society, per Bessersche Buchhandlung, *Behren-str.*, 7, *Berlin*.
BOLOGNA, .	Academia della Scienze dell' Instituto.
BORDEAUX, .	Imperial Academy of Sciences.
BOSTON, . .	American Academy.
	Natural History Society.
BRISTOL, . .	Institution for the Advancement of Science, Literature, and the Arts.
BRUSSELS, .	Academy of Sciences.
CALCUTTA, .	Public Library.
	Geological Survey of India.
CAMBRIDGE, .	Philosophical Society.
	University Library.
COPENHAGEN,	Royal Society of Science.
CORK, . . .	Queen's College Library.
	Royal Institution.
CORNWALL, .	Royal Polytechnic Institution.
DIJON, . . .	Academy of Sciences.
DUBLIN, . .	Royal College of Surgeons' Library.
	Royal Irish Academy.
	University Library.
	Royal Dublin Society.
	Natural History Society.
	Ordnance Survey Library.
	Professor Sullivan, as Editor of the "Atlantis."
	Geological Survey of Ireland.
	University Natural Science Association.
	Institution of Civil Engineers.
EDINBURGH, .	Royal Society.
	Wernerian Society.
	Society of Arts.
	University Library.
	Society of Antiquaries.
FLORENCE, .	Society of Physics and Natural History.
GALWAY, . .	Queen's College Library.
GENOA, . .	Society of Physics.
GLASGOW, . .	University.
GÖTTINGEN, .	University.
HANAU, . .	Oberhessische Gesellschaft der Natur-und Heil-kunde.
HANOVER, .	Royal Library
KILKENNY, .	Archæological Society.
KÖNIGSBERG,	Königlich Physikalisch-Oekonomische Gesellschaft.
LAUSANNE, .	Société Vaudoise des Sciences Naturelles.
LEEDS, . .	Geological and Polytechnic Society of the West Riding of Yorkshire.
	Philosophical and Literary Society.
LEIPZIC, . .	Royal Society of Sciences (Saxony).
	University.
LIVERPOOL, .	The Literary and Philosophical Society.
	Historic Society of Lancashire and Cheshire.

LONDON, . .	Geological Survey, *Jermyn-street.*
	British Museum.
	Society of Arts, *John-street, Adelphi.*
	Royal Institution, *Albemarle-street.*
	Royal Society, *Burlington House.*
	Geological Society, *Somerset House.*
	Linnean Society, *Burlington House.*
	Geographical Society, 15, *Whitehall-place.*
	Civil Engineers, Institution of, 25, *Great George's-street, Westminster.*
	Royal Asiatic Society, 5, *New Burlington-street.*
	Royal College of Surgeons.
	Zoological Society, 11, *Hanover-square.*
	Athenæum, 14, *Wellington-street, Strand, W. C.*
	Literary Gazette.
LYONS, . .	La Société Impériale d'Agriculture, d'Histoire Naturelle, et des Arts Utiles.
	Société Linnéen.
	Academie Impériale.
MADRID, . .	Academia de Ciencias.
MANCHESTER,	Literary and Philosophical Society of. [Sec., R. C. Christie.]
	Geological Society.
MELBOURNE, .	Philosophical Institute of Victoria.
MILAN, . .	Reale Instituto Lombardo di Scienzi.
MISSOURI, . .	State Survey and University, *Geological Rooms, Columbia, U. S. A.*
MODENA, . .	Imperial Institute of Science.
MONTREAL, .	Natural History Society.
MUNICH, . .	Royal Academy of Science (2 copies).
NEUCHATEL, .	Société des Sciences Naturelles.
NEW HAVEN,	The Editors of Silliman's Journal of Science and Art.
OXFORD, . .	Bodleian Library.
	Ashmolean Society.
PARIS, . .	Ecole Polytechnique.
	Geological Society.
	L'Ecole Impériale des Mines.
	Institute of France.
	Bibliothéque Impériale.
	Jardin des Plantes, Bibliothéque.
PHILADELPHIA,	American Philosophical Society.
	Natural History Society.
PLYMOUTH, .	Plymouth Institution and Devon and Cornwall Natural History Society.
QUEBEC, . .	Literary and Historical Society.
ROME, . . .	The Vatican Library.
ROUEN, . .	Academy of Science.
ST. ANDREWS,	University Library.
ST. LOUIS, . .	Academy of Sciences.
ST. PETERSBURG,	Imperial Academy.
	Central Physical Observatory of Russia.
	Russisch-Kaiserliche Mineralogische Gesellschaft.
STOCKHOLM, .	Royal Academy of Science.
STRASBOURG, .	Société des Sciences Naturelles.
TORONTO, C.W.,	Canadian Institute, per Thomas Henning, Esq.
TOULOUSE, .	Academy of Sciences.
TURIN, . .	Royal Academy.
UPSALA, . .	Royal Society of Sciences.
VIENNA, . .	Imperial Academy of Sciences.
	Prof. W. Haidinger, of Vienna, as Editor of the "Jahrbuch der K. K. Geologischen Reichs-anstalt."
WASHINGTON,	Smithsonian Institute Library, per Henry Stevens, Esq., *Morley's Hotel, Trafalgar-square, London.*

No. V.

ABSTRACT OF TREASURER'S ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1862.

1862. Dr.	£ s. d.	£ s. d.
To Balance from last year's Account,		28 4 0
— Amount of Subscriptions received for year ending December 31, 1862:—		
— Life Compositions,	£20 0 0	
— Half-life Compositions,	10 0 0	
— Admission Fees,	8 0 0	
— Annual Subscriptions,	81 0 0	
		119 0 0
— Amount of Dividend on Government Stock,		6 1 4
		£153 5 4

1862. Cr.	£ s. d.	£ s. d.
— Mr. Gill, Balance of Account for Printing (per Draft 547),		26 5 3
— Sundries, (per Draft 548),	11 0 8	
— Porter's Wages,	7 17 6	
— Carriage of Books,	1 12 5	
— Palæontographical Society, subscription,	3 3 0	
— Gratuity to Attendant,	1 10 0	
— Mr. Oldham, for Woodcuts,	3 15 0	
		28 18 7
— Assistant Secretary, half-year's Salary, to June 30, (per Draft 549),		10 0 0
— Mr. Gill's Account for Printing (per Draft 550),		40 0 0
— Sundries (per Draft 15851)	4 15 1	
— Porter's Wages,	6 12 6	
— Carriage of Books,	1 15 2	
— Subscription to "Annales des Mines,"	3 0 0	
— Mr. Tallon's Account for Stationery,	1 10 0	
— Mr. Gill's Account for sundry Printing,	4 4 8	
		21 17 5
— Assistant Secretary, Half-year's Salary, to December 31, 1862 (per Draft 15852),		10 0 0
		£137 1 3
— Balance in Bank,	£11 4 1	
— Cash in hands,	5 0 0	
		16 4 1
		£153 5 4

I have examined the above Account, and compared vouchers, and find a balance in Bank of £11 4 1
And in hands of Treasurer, ... 5 0 0
£16 4 1

February 4, 1863.

(Signed) ROBERT REEVES, *Auditor*.

MINUTES OF PROCEEDINGS OF THE YEAR 1862-63.

General Meeting, March 12, 1862.

The President in the Chair.

The Minutes of last meeting were read and confirmed, donations were announced, and thanks voted.

Mr. W. H. Baily read a short description of the lately discovered gold-field at Tuapeka, in the province of Otago, Middle Island, New Zealand, prefacing it by a few remarks on the geology of that country, which appears to correspond in its general rock systems and the gold-bearing deposits with those of Australia. The description of this productive gold-field was communicated to Mr. Baily in a letter from Alfred Francis Oswin, Esq., Member of the Provincial Council of the province of Otago, of which the following is an extract:—

"*Dunedin, Sept.* 19, 1861.

"On July 20th we formed a party of four, and, with supplies for two months and tools, started. We had also a dray and eight bullocks. On the Tuapeka diggings I remained for eight weeks, and will endeavour to give you a description of the gully we were working in, named 'Gabriel's Gully,' in honour of its discoverer, Mr. Gabriel Reed. The ridges enclosing it run from a leading ridge of some altitude (now covered with snow). The gully is about two and a half miles long, varying in breadth from 250 to 50 yards. There are some 3000 men working in it. The finds vary from 3lbs. weight (to a party of seven) to 3 dwts. per day. I speak of the highest and lowest that I was myself cognizant of. We never made more than four ounces per day, and we worked three weeks without seeing a speck. The gold is scaly; the largest nugget was only 15 dwts., and I have only heard of two. I enclose gold from our claim:—No. 1, the finest; No. 2, the coarsest. It appears to be pretty well scattered throughout. 'Bottom,' or rock, is found at from 8 to 12 feet; our claim was 4 feet 6 inches in depth, bottom consisting of a very hard blue slate. In the fissures was a semi-rotten stone of the colour of rust. In it we generally found the most gold. I went out 'prospecting' as others did, for miles round; all found gold, but only in sufficient quantities to earn wages—i. e., £1 per day per man. I have every hope that other rich gullies will be found."

M. Alphonse Gages, who kindly examined the small quantity of gold sent from these diggings, found in sample No. 1 sufficient debris to determine the probable character of the associated rocks. There were particles of quartz rock and slate, probably Cambrian or Silurian, with one or two grains of jade, or nephrite, together with magnetic iron, iron pyrites, small garnets, &c.

The last accounts from Dunedin, Nov. 9, 1861, were highly satisfactory (although the provincial government of Otago thought it necessary to warn the public generally not to rush inconsiderately to those diggings), 19,700 ounces of gold having been brought down by the last escort; and 20,000 ounces in addition were reported to have been left behind at Waitahuna, where new and rich diggings had since been discovered, nine miles nearer Dunedin. The remarkable correspondence between the general rock systems and gold-bearing drifts in Australia and those of New Zealand affords encouragement to hope that similar large discoveries of gold will be realized in the latter country, more especially as there are certain indications of its being distributed over a large area in this comparatively unexplored island. The valuable coal deposits in different parts of the middle island also appear to be similar in character and geological age, most of them belonging, like those of Australia, to the great Oolite formation. When this mineral wealth, therefore, shall have been more fully developed, and the resources of the country opened up, New Zealand, combined with its natural advantages of situation and climate, bids fair to be one of our most important colonies.

The President read a paper—"Geological Notes on the Iron and Manganese Ores, and on the China Clay of Kilbride." The townland of Kilbride, in the county of Wicklow, is based on granite, the rock pretty deeply covered with clay, chiefly composed of granite detritus. Boulders of granite are very numerous, and in one part (for a few acres) intermixed with boulders of trap or greenstone. Several of the granitic boulders, on being split, present the appearance of concentric rings, as if the stones had increased from the centre. In a few instances central balls separated from their outer casings, as would the kernel of a nut from its shell. In others, part of the outer coating or shell was broken off, leaving the rounded kernels, or nuclei, exposed on one side, whilst the other remained embedded firmly in its stony husk. One boulder (about nine feet long by six feet broad, and as many deep), on being split down the centre, presented a dark well-defined streak, in the form of an oval-shaped ring of six feet long by three in diameter at the centre. The streak was about six to eight inches in breath, dark at the outer rim, but becoming paler and fading in colour towards the centre, until it blended insensibly into the same colour with the rest of the stone. There was no disposition in this ring to separate from the outer casing, with which it appeared to be thoroughly incorporated. The stone has now been cut up into gate posts, but much of the ring may yet be traced in the separate parts. He then alluded to the "pitchy iron ore," containing—

Peroxide of iron, ...	77·15
Water	20·43
Phosphoric acid	1·60
Argil	1·30
	99·48

This occurs, associated with brown hæmatite and psilomelane, in a great lode, bearing N. W. It contains much more water than is usually found in hæmatite, to which genus, however, it should probably be referred. He then described the china clay, which had been tested by a manufacturer in Worcester, and which had stood the "stone heat" (6000 degrees F. by Wedgwood's pyrometer) very well.

Mr. Du Noyer remarked that very fine china clay was to be found between Bagnalstown and Nurney, county of Carlow.

Mr. Scott read the following letter from the Rev. John Storrs, on "The Gold Fields of Nova Scotia."

"*St. John's Rectory, Cornwallis, N. S., Feb.* 5, 1862.

"DEAR SIR—I am obliged for your letter and information, which I hope to act upon. Since yours I find from many quarters that the return of gold at nearly all our diggings is greater than appearances of quartz indicated—i. e., after the process of crushing, the yield has agreeably surprised the most experienced. I have heard from several miners that, contrary to what they had often seen in Australia and California, the rock (here) which on the exterior presented no appearance of gold had yielded considerable. They all tell me that they have made good wages, except the intemperate—say from one and a half to three dollars *per diem;* and some few favoured ones more than that remuneration. One great drawback is our long winter, say six months, and I cannot see how mining operations during that time can be carried on. The only work which usually goes on in the winter is wood-cutting and preparing timber for foreign markets. The miners tell me none of them have made fortunes, but good wages—say, on an average, two dollars per day. I now tell you this, fearing that my previous information might lead you to form too low an estimate of us. Should you visit the Great Exhibition, I must request you to inspect the Nova Scotia quarter, and see the specimens of grapes which are to be there, and which grew in the open air near to my residence. You will see pearls also, which were found in a fresh-water mussel. I should not imagine that large quantities of pearls will continue to be obtained. The man who first made the discovery kept it a secret until he had, as he imagined, secured all the shell-fish. It is said he has a bushel of pearls, but as yet the value of them is not known. They were found in a stream about twenty-five miles from me.—I am yours very sincerely,

"JOHN STORRS.

"*Rev. Professor Haughton, T. C. D.*"

The President remarked that in the gold-fields of Nova Scotia the gold was found in a bed of quartz which is interstratified with the mica slate, and not in a lode. His opinion was, that gold had originally existed in the gravels of all parts of the world, and that it had become very rare in the old countries in consequence of the fact that the inhabitants had picked up all of that metal which was to be had.

A meteoric stone, or aërolite, from Dhurmsalla, in the Punjaub, was exhibited; and a letter from the Deputy-Commissioner, describing the circumstances under which it fell on the 14th of July, 1860, was read (p. 7).

The meeting then adjourned.

General Meeting, April 2, 1862.

The President in the Chair.

The Minutes of last meeting were read and confirmed, donations were announced, and thanks voted.

Mr. George Kinahan, Roebuck Hill, Dundrum; Dr. Edward Bennett, 25 Holles-street; and Mr. W. R. Trench, were elected members of the Society.

A specimen of the head and horns of the barren-ground variety of the reindeer, found near Ashbourne, county of Dublin, was exhibited; also the upper portion of the femur of a moa, found at Canterbury, New Zealand; and also a specimen of oolitic iron ore from Milwaukie, Michigan, United States of America.

Mr. Robert H. Scott, Honorary Secretary, read a paper, by Messrs. Denny and Townsend, on a "Section near Tralee."

Mr. H. E. Bolton read a "Notice of the occurrence of Manganese Ore, and Sulphate of Barytes, in the county of Dublin." He stated that during the last Christmas holidays he was examining some of the rock districts in the northern portion of the county of Dublin; and having observed a few facts not before recorded, he thought it might be interesting to submit them to the Geological Society with a view to their preservation. The district in which he discovered the manganese was in the locality of Portrane, about twelve miles from Dublin, on the coast adjacent to Lambay Island. He found the ore in a bed of dark coloured clay; the ore contained much water, and before the blowpipe with borax gave a deep purple glass.

Mr. R. H. Scott read the following communication on the occurrence of nickel in mica slate, from Curraun, county of Mayo, by Mr. Emerson J. Reynolds:—

"Sir—I beg to enclose a specimen of mica slate from Curraun, county of Mayo, in which I and Professor Cameron have found nickel in the proportion of ·02 per cent. This element is, I believe, rarely met with in Ireland, therefore I trust that this observation may be interesting to you.—I remain, truly yours,

"Emerson J. Reynolds.

"*Rev. Professor Haughton.*"

The President read the following letter from Mr. Robert Mallet, in reference to the foregoing papers:—

"*London*, 30th *March*, 1862.

"My dear Sir,—At a distance here from our well-remembered geological meetings, I still take the greatest interest in what goes on. In connexion with papers which I see are to be read on the 2nd April, it may perhaps not be inopportune to mention:—First, many years ago, when I was a lad, shafts were sunk for lead at Dalkey, in the granite, and I believe, though covered over, they still exist not far from where Sorrento-terrace now stands. Lead was found with some antimonial lead, though not abundantly, but the gangue appeared to be almost completely sulphate of barytes, in massive crystallized form, nearly milk-white. I once had a large quantity of pure barytes prepared by myself from it, and recollect that it contained sensible traces of strontian. Again, about thirty years ago, a large boulder stone existed on the strand to the north of Dolly-

mount, dry at low water, which was Old Red Sandstone, obviously 'travelled' from Donabate, where the Old Red occurs to the north. Through this stone ran thin veins of sulphate of barytes, a rather unusual thing in Old Red rock anywhere. It suggests the possibility of the existence of a vein of the same being found *in situ* at Donabate or elsewhere northward. In reference to the next paper, on the occurrence of nickel in the county of Mayo, I may remind you of having ere now mentioned to the Geological Society my having found Haarkies in acicular crystals with lead ore, at Shaffray mine, near Croaghpatrick, in that county. I think it not improbable that nickel may yet be discovered in workable quantities somewhere about the Mayo region in Ireland. The Haarkies was found in greenish grey clay slate, if I recollect right, with much feldspar about the galena, and a good deal of disseminated copper pyrites.

"Sincerely yours,

"ROBERT MALLET.

"*The President of the Geological Society, Dublin.*"

The President said, having read the foregoing paper, that these indications of nickel in Croaghpatrick, in Mayo, and at Maam, Galway, where he had found a specimen about a year ago, were highly interesting, and he expressed his concurrence with the observations made by Mr. Mallet.

Mr. Gilbert Sanders said the granite of Dalkey had many veins of sulphate of barytes. In the old mine on the sea-shore at Killiney there were four or five veins of it. There was a vein of sulphate of barytes, two or three inches thick, near Dalkey Church. Also at Salt Hill, near the ladies' bathing place, there was another vein of the same mineral close down on the beach.

The Secretary read a paper by Mr. T. W. Kingsmill—"Notes on the Geology of the South and East Coasts of China" (p. 1).

Mr. Jukes remarked that the paper possessed peculiar interest, as it contained a complete sketch of the geology of that part of China which Mr. Kingsmill was able to observe. The succession appeared to be the same as in Ireland, except that the coal was better. The pseudo-boulders described by Mr. Kingsmill had been also observed by himself in the tropical parts of Australia. They were not boulders carried by ice, but great blocks of granite disintegrated *in situ* by the weather and the great tropical rains. He congratulated the Society on the fact that an old member of it had furnished them with such a valuable paper.

The President stated that, as he had been referred to in the paper, he would state that the analysis made by him was of the mica from veins in the granite. The rock itself is decomposed to such an extent that it is not possible to obtain specimens worth analyzing. He found two feldspars, orthose and oligoclase, just as in the European granites. The fossils which had been sent to him by Dr. Thornton from China were orthoceratites, not to be distinguished from Irish specimens. Captain Blackiston, who had assisted Mr. Kingsmill in his determination of the fossils, was already well known to science for his investigations in the Crimea, connected with the natural history of that country, and for his magnetical observations in the Hudson's Bay district.

Dr. Carte then communicated the following notice of the discovery of the magnificent head and horns of the American reindeer, *Tarandus rangifer*, var. *Arcticus*, at Ashbourne, county of Dublin, which he had brought down for exhibition to the Society. He stated that the animal to which they had belonged, had been one of the "barren ground" variety of the American reindeer, which is now confined to the extreme northern part of the American continent. As far as he was aware, all the specimens of reindeer which had been found fossil in Ireland belonged to this variety, while the European variety was that found fossil in Great Britain and on the old Continent.

The meeting then adjourned.

GENERAL MEETING, MAY 14, 1862.

THE PRESIDENT in the Chair.

The Minutes of last meeting were read and confirmed, donations were announced, and thanks voted.

A specimen of hæmatite from Cloghill, Kilbride, presented by Mr. Scott Moore, was exhibited; also a nodule of iron pyrites from calp limestone, found forty feet below the surface in digging for the foundation of the new Molyneux Asylum, Upper Leeson-street.

Mr. J. Beete Jukes, M. A., F. R. S, read a paper "On the mode of Formation of some of the River Valleys of the South of Ireland," of which the following is an abstract:—

In this paper, for the full illustration of which costly maps and sections would be requisite, Mr. Jukes gave the results he had lately arrived at respecting the reason for some peculiarities in the courses of some of the rivers of Ireland. He first called attention to the fact that it was possible to cross Ireland from Dublin Bay to Galway Bay, from the basin of the Liffey into that of the Barrow or the Boyne, and thence across both water-sheds of the Shannon, without going over ground that was higher than 300 feet above the sea; and that all this low ground was limestone ground. Nevertheless, the Shannon about Killaloe, the Barrow below Goresbridge, the Nore below Thomastown, and the Suir about Waterford, cut by deep winding valleys through ground made of Lower Silurian and Old Red Sandstone rocks, the mean height of which is at least 600 or 700 feet above the sea. These valleys are certainly valleys of erosion made by the rivers; but if they were to be blocked up, the rivers could not now cut them open, since their pent-up waters would flow over the low limestone ground into Dublin or Galway Bays, rather than in the direction of their present courses.

He then called attention to three rivers in Munster, namely, the Blackwater, the Lee, and the Bandon; and he showed that each of these ran for many miles along longitudinal east and west valleys parallel to the strike of the rocks and the hill ranges of the country, and that those valleys continued out to the sea in straight lines, and without any change of form. The rivers, however, instead of continuing along these valleys to the sea, suddenly turned from them, and ran at right angles across several high rocky ranges on the south side of the valleys, through deep ravines, up which the tide came as far as the proper longitudinal valley of the river.

The ravines of the Blackwater are those between Cappoquin and Youghal; those of the Lee are at Passage West and Passage East, and the one at the entrance to Cork Harbour; and those of the Bandon occur about Innishannon, and between it and Kinsale Harbour.

In each of these three cases, Mr. Jukes pointed out that strong lateral brooks came from the higher ridges on the north into the longitudinal valleys nearly opposite the point where the transverse ravines commenced.

The Brinny falls into the Bandon River near Innishannon; and the valley between that point and Kinsale is rather the valley of the Brinny than that of the Bandon River.

The Glanmire brook comes through a deep glen into the Lee, nearly opposite the opening between Blackrock and the Little Island; and its channel is continued thence to the ravine of Passage West. The Owenacurra issues out of a similar glen at Ballyedmond, and, after running past Midleton, turns towards the ravine of Passage East. These two channels unite in Cork Harbour, to the east of Queenstown, and form the channel that runs out to the ravine at the entrance of that harbour.

On the Blackwater River two large brooks come out from deep glens on the flanks of the Knockmealdown Mountains—one opposite Lismore, and the other a little east of Cappoquin, which would naturally unite about the entrance of the first ravine, that of Dromana, below Cappoquin.

By referring to the one inch geological map of Ireland (now suspended at the end of the Palæontological Gallery in the Museum of Irish Industry), it will be seen how directly the transverse ravines are in all these cases related to the lateral brooks which come down from the higher ridges on the north, seeming to be the natural continuations of the courses of those brooks. Mr. Jukes, therefore, believes that they are so; and that in some former condition of the surface, before the erosion of the longitudinal valleys, and the consequent appearance of the ridges between them, and while the surface of the ground was a little above the summits of those ridges, with a general slope from the dominant ranges on the north towards the sea on the south, these brooks commenced to run, and to cut a channel for themselves on the then existing surface of the ground, and that they have ever since been occupied in deepening the channels thus originally traced out.

This hypothesis involves the supposition that all the subsequent modelling of the country, by erosion of that original surface of the ground into its present form, and the production of the longitudinal valleys and their intervening ridges, has been effected upon dry land by atmospheric action alone. This supposition is supported by the fact of the longitudinal valleys always running along the softer parts of the arenaceous and argillaceous rocks, or those most easily disintegrated, and especially along the synclinal hollows in which the limestone lies—a substance which is subject not only to the mechanical action of erosion, but also to the chemical power of solution possessed by the carbonic acid of the atmosphere and the rain water.

The lateral brooks above mentioned were sufficiently powerful, originally, to cut channels, which the waters have been able to keep open ever since; so that, as the general surface of the country was lowered by weathering, and as the longitudinal valleys came into existence by the same action, the drainage of the adjacent country was always turned into these channels, and ran down them. Other lateral brooks did not succeed in keeping their channels open across the ridges on the south sides of the valleys, as the surface of those valleys sank, but were turned aside by the ridges into the valleys, where they united their waters to produce the larger rivers; but the brooks that formed the transverse ravines above mentioned were able to do this, and were even assisted in doing it by the additional drainage they received from the longitudinal valleys according as these became more and more extended.

Mr. Jukes then proposed to apply this explanation to the rest of the south of Ireland, and to suppose that the Shannon, the Suir, the Nore, and the Barrow originally ran over limestone ground which was 400 or 500 feet higher than the present surface, so that the gorges at Killaloe and those of the rivers which flow into Waterford Harbour, although not nearly so deep as at present, were nevertheless the lowest outlets from the interior of the country, and the rivers ran down them accordingly; and that, although that limestone ground has been subsequently lowered by weathering down to its present level, the rivers running over it always kept their own channels open, and were able by the force of their streams to cut the valleys through the other rocks and keep them deep enough to be lower than any part of the wasting plain of limestone.

It is, of course, quite possible that, during the fearful lapse of time requisite for such an action as the mere weather to have dissolved and removed a thickness of several hundred feet of rock from off the general surface of the country, Ireland, with the British Islands and Western Europe, may have stood at many different levels with respect to the surface of the ocean. The whole country was probably at one time at a much higher level than it is now. It is certain that during the glacial period it was from 1500 to 2000 feet lower than now, so that the sea flowed over all but the tops of our mountains. which would then be small islands. These general movements of elevation and depression, however, have had no direct effect on the production of the features of the ground. The originally horizontal beds of the Carboniferous formation were, as Mr. Jukes believes, originally covered by a subaqueous plain of Coal-measures, spreading over all Ireland. Internal forces of disturbance bent these horizontal rocks into many undulations and contortions. Marine denudation, acting like a horizontal plane, cut off and removed a certain thickness of the rocks along the successive margins of the land as they rose above the sea, producing doubtless a somewhat unequal effect on the different parts it met with, that had been previously placed at different levels and in different positions by the internal disturbing forces. The positions of the subsequent mountains, plains, and valleys, were probably sketched out by this marine denudation acting on the variously disposed substances. The features thus faintly traced have been subsequently graved deeper and deeper by the vertical action of atmospheric degradation, the amount of which is now shown to have been much more considerable than has hitherto been imagined.

If the explanation now offered be accepted, it will have a much wider application than the south of Ireland, and may, as Mr. Jukes believes, be extended to all the dry lands of the globe.

The President said that Mr. Jukes had brought before them, in a highly interesting and original manner, a very curious subject, in which he himself had long felt much interested. The poet Spenser commented on the perverse course followed by the three

sister rivers—the Nore, the Suir, and the Barrow. While the geological and physical structure of the regions through which they passed would seem to lead them in a direction from west to east, they suddenly, in a most extraordinary manner, changed their courses through ninety degrees, and ran southwards. They owed thanks to Mr. Jukes for the ingenious manner in which he had brought forward views quite novel. According to those views, a river, like a nation, had its history; and every bend where it turned from a valley, which everted it into another which did not do so, was a record of a past stage of that river, and an indication that they must seek for former conditions of the land that permitted it to take that particular bend. The President, in expressing his own views on the subject, attributed the change in the river valleys partly to the existence of a series of joints or fissures in the rock formations prior to the period of the earlier river channels.

The meeting then adjourned.

General Meeting, June 11, 1862.

The President in the Chair.

The Minutes of last meeting were read and confirmed, donations announced, and thanks voted.

R. Hudson, Esq., F. R. S., and the Rev. Maxwell Close, were elected non-resident Life members.

The President announced that as the author of the first paper on the list was present, but was not a member of the Society, he would, with the permission of the Society, request Captain Meadows Taylor to read his paper, instead of its being read by the Secretary.

Captain Taylor then read his paper—"A Sketch of the Geology of Shorapoor, in the Dekhan" (p. 24).

The President stated, that he had seen some of Captain Taylor's drawings of the results of denudation on a recent occasion, when he was reading a paper at the Royal Irish Academy, and had requested him to lay a description of the district before the Geological Society. He felt sure that when the admirable sketches made by Captain Taylor appeared in the "Journal," they would supplant the ordinary representations of denudation to be found in text-books. He suggested that possibly there might be some peculiarity in the chemical constitution of the granite which rendered it liable to very extensive erosion.

Captain Taylor regretted that he had not brought over specimens which could be analyzed.

Mr. Jukes expressed the great interest he had felt in hearing Captain Taylor's paper. He had himself examined some of the perforated rocks alluded to by the author, but had not been able to come to a definite conclusion as to the cause of the perforations. He was inclined to think that the cause of the extensive denudation in tropical regions was to be sought for to a great extent in the activity of atmospherical agencies.

Mr. Kelly was called upon to read his paper on the five Palæozoic Red Sandstones. He began by stating that the Old Red Sandstone is a band of rock which appears to have been more misunderstood by geologists than any other group of the stratified rocks. It is with a view to fix the position of this band, and to have but one band of rock bearing that name, that he put together the following observations:—Much confusion has been introduced into geology by recent system-makers—by introducing new names for certain bands of rock—by cutting away bands from some of the formations, and adding those bands to others—thus making artificial boundary lines between formations, instead of adopting the boundaries made by nature. There is, perhaps, no country in Europe in which the Carboniferous Limestone is better developed than in Ireland—which, with the Old Red Sandstone under it, and the coal measures over it, all three have conformable, parallel beds, and constitute a remarkable system in themselves. This system has the

further peculiarity, that its beds lie unconformably on the several kinds of older rocks which support it, and it is covered unconformably by the newer rocks which surmount it. Those circumstances render it in Ireland one of the best defined and independent of all the formations in geology. To assist in justifying the views he entertains, the author of the paper gave a statement of the thickness of each of the first four of the Red Sandstones known:—1. The first is the primary Red Sandstone of Sutherland, at Coulmore, 2500 feet thick—then 7500 feet of mica slate, quartz rock, and primary limestone alternating; then the Cambrian rocks, 51,000 feet thick, making 58,750 feet between the first and second Red Sandstones. 2. The second is seen at the base of the Silurian rocks at Glencraff, Maume, Boocaun, and Kilbride, in Connemara, 400 feet thick, between Killery harbour and Lough Corrib. From the second to the third bands includes the whole of the lower and upper Silurian systems, making about 28,000 feet thick. 3. The third Red Sandstone is the Devonian, and from the base of this to the top is about 40,000 feet, as seen in North Devon—the red part below being interstratified with green and grey grits and slates for more than three-fourths of this thickness. 4. The Old Red Sandstone, lying unconformably on all the supporting rocks of every kind—this is the basal band of the Carboniferous rocks—is about 1000 feet thick, and the whole formation in some places (South Wales) 11,000 feet. 5. A fifth Red Sandstone, the New Red, lying unconformably on the coal series, recently called Permian, into which, having no taste for new names, he would not enter. 1. The first of these, the primary Red Sandstone of Coulmore, described by M'Culloch, we have not in Ireland; though the superincumbent mica slates, quartz rocks, and primary limestones we have in Donegal, Derry, Mayo, and Connemara. 2. The second is described above, and lies unconformably on the primary rocks. 3. The third has been called Devonian. or Old Red Sandstone. This group is accumulated on the Silurian rocks conformably, as is seen near Ludlow in Herefordshire, and continues up to the Vans of Brecon in South Wales. Every Red Sandstone known, except one (the New Red), has been called by this name. Miller made no distinction in Scotland between the one and the other, though some of the groups have thousands of feet in thickness of other rocks between them, as already stated. All the Old Red Sandstones of Sutherland, and Hereford, and Devonshire, and the Vans of Brecon, go by this name, as arranged by Sir R. Murchison. The present condition of these Red Sandstones may be illustrated by a Venetian blind. Paint two or three of the lower bars red, also two or three of the upper, a like number at one-third and at two-thirds of the height; paint all the rest green. Now pull the string, and raise all to the top, where there will appear a prevalence of red bars, that being the most striking colour, all in juxtaposition. Thus it is, that all the Red Sandstones, quartzites, and grits, are shown in some books like the blind drawn up. Every red group is called Old Red Sandstone, and the intervening groups often left unnoticed. It is when the blind is down, the spectator can see how much green there is, and how little red. The graywacké group of rocks, as it was known forty years ago, is of vast thickness. It has been recently divided into Silurian, the lower part, and Devonian, the upper. There is no natural boundary between those two divisions; but the Silurian beds are grey shales and grits, containing peculiar fossils; the Devonian are known by a mixture of green, grey, and red beds, with little or no fossils. He thought the Devonian rocks might be subdivided into two groups; the lower to consist of red and green grits and slates, as they appear in the Cork and Mallow Railway cutting; in the Boggra Mountains, Glanflesk, the tunnel near Killarney, Macgillicuddy's Reeks, &c.; the upper to include all the dark grey slates and flags about Bantry Bay, Coomhola Valley, and Shehymore summit; also the coast south of Ringabella, near Cork harbour; at Mohona, Benduff, near Roscarberry, the Leap, and several other localities in South Cork. In Tyrone, though the lower is present, the upper Devonian is absent. It is so also in Antrim. But the upper Devonian occurs of great thickness in Cornwall, at Petherwin, to the south of the culm district. This is the grand group of slates and flags described by Professor Sedgwick in "Brit. Pal. Fos.," Introd. p. 28. The dark grey rocks of the upper lie conformably on the red and green of the lower; but a distinction between them is warranted, if for nothing else but lithological appearance, which is apparent in the difference between the red and green grits and slates of the lower, and the dark grey slates and flags of the upper, in which there are no red rocks. This subdivision of the Devonian rocks, how-

ever, does not agree with one made by Sir Charles Lyell, in his "Manual of Geology." He included the Yellow Sandstone in his upper. I throw it out, and put it where it ought to be in the Carboniferous series. The author of the paper made an approximation to the whole thickness of this Devonian series in North Devon by sections made across certain zones, which the authors of the Devonian system did not attempt. The result of his trial gave 39,115 feet. A similar trial section across the Devonian district from Clyro to Monmouth, in Wales, gave a result of 37,000 feet. The culm rocks of Devonshire lie unconformably on the Devonian rocks in Devonshire and Cornwall, as shown by Mr. Weaver, "Proceedings Geological Society, London," ii. 590; by Mr. Godwin Austen, "Transactions Geological Society," second series, vi. 457, and by myself, who never saw the Carboniferous rocks anywhere lie conformably on the older supporting rocks. The authors themselves express a doubt as to the geological base of the culm.—"Transactions Geological Society," Second series, v. 684. In Brecon the Upper Devonian series appears not to be fully developed. The dark slates and flags of Shehymore in Cork and Petherwin do not occur there. This absence of a group of rocks is not uncommon. In the barony of Cary, in Antrim, chalk rests upon mica slate, between Cushendun and Ballycastle, in three places—Knocklayd, Ballypatrick, and Carnlea, making a great hiatus, in which the Cambrian formation is wanting; also the Silurian, the Devonian, the Carboniferous, the New Red Sandstone, the Oolite, Lias, and Green Sand. The absence of a geological group from the place where it might be expected in the sequence is almost as common as its presence. For instance, take the four Palæozoic Red Sandstones, the subject of this paper—1. The primary sandstone of Sutherland, which underlies the mica slates, quartz rocks, and crystalline limestone, is absent under similar rocks in Donegal, Derry, Mayo, and Galway. The rock which underlies the primary rocks of those counties is not Red Sandstone, but syenite, at Dunaff Head, in Donegal. 2. The second Red Sandstone, which lies at the base of the Silurian system in Connemara, is not seen in the Silurian districts of Tyrone, Kildare, Wexford, or Waterford, nor in England or Scotland anywhere else. 3. The Devonian Red Sandstone of Hereford, Devonshire, Cork, and Kerry, is not known in the northern counties of England, Scotland, or Ireland, except two districts. 4. The well-known Old Red Sandstone of the Carboniferous system is absent under the great culm district of Devonshire. Thus every one of those Red Sandstones is at home in some localities of the British Islands, and away from home in others. The author next showed that the Old Red Sandstone was very badly treated by recent writers; they ignored it, and put it in their book-learning out of its place. The name is still retained as of high repute, but applied to other rocks, belonging to different epochs. He then quoted passages from the opinions of writers thirty years ago, before the new innovations appeared, and gave them in the order of their dates. Weaver wrote upon it, and Conybeare and M'Culloch, as also Phillips, Austen, Stevenson, and Cuming. Murchison wrote in 1839, and altered the classification that existed before his time. To this band he added a part of the graywacke of Hereford and Brecknock, which is a rock of another geological epoch, and called the whole Devonian, or Old Red Sandstone. But the Devonian is not Old Red Sandstone, nor is the Old Red Sandstone Devonian. Near the Vans of Brecon the Old Red Sandstone, which is a part of the Carboniferous series, lies unconformably upon green and brown grits and slates of the Devonian series. This he showed by quotations from Professor Sedgwick's writings, and those of Sir H. De La Beche, as well as from his own observations. In this case the unconformability between the Carboniferous and Devonian rocks was overlooked by the author of the Silurian system, and this was one of the greatest errors promulgated in geology the last twenty years. This mistake, and the alteration in the classification of rocks founded on it, made a great change in geological matters in England on the publication of the Silurian system. The views of the author were adopted by all. No one questioned them, or went anywhere to see whether they were right or wrong. Sir Charles Lyell followed in his wake, but never went to look at the quartzose conglomerate at the base of the Carboniferous Limestone near the Vans of Brecon. All the English text books and school-books on geology of the present day are on the same model; and if all this be founded on a mistake, such as I have described, and as I believe it is, those changes may be deplored as a bar to the progress of the science and of truth. One of the greatest evils in the study of natural science is the alteration of names during its progress. There is

some excuse for changing the names of fossils, of which it is often difficult in the beginning to get good specimens, but none for altering the name of a zone of rock. When a man has got the stony character of a rock well imprinted on his mind, he never forgets it. In this view it looks like a crime to change the name of a well-known rock for the sake of putting a feather in an author's cap. The Old Red Sandstone has been robbed of its character, ignored, and merged into another formation, to which it does not belong. In Ireland it stands out prominently as a well-defined geological zone, the lowest of the Carboniferous system. It is desirable that for this band we should return to the old name, and have no Old Red Sandstone in geology but the one. Let the term Devonian be applied to the upper red, green, and grey rocks of the greywacke. The Old Red Sandstone of Scotland appears to remain yet without being clearly made out. Part belongs to the primary sandstone of Sutherland and Ross—perhaps part (Forfar) to the Devonian; —part (Dura Den) to the Carboniferous Old Red Sandstone; they are all confounded in the Old Red Sandstone of Scotland. The five sandstones I have enumerated are all distinct bands, and separated from each other by many thousands of feet of other rocks not usually called sandstones.

The President stated that, owing to the lateness of the hour, he could not call for any discussion on Mr. Kelly's valuable paper.

A paper by Mr. J. Beete Jukes, "On the way in which the Calamine occurs at Silvermines, county of Tippérary," was laid on the table (p. 11).

The meeting then adjourned.

GENERAL MEETING, NOV. 12, 1862.

The PRESIDENT in the Chair.

The Minutes of last meeting were read and confirmed, donations were announced, and thanks voted.

H. Still, Esq., 6, Besborough-terrace; D. J. Rowan, Esq., Merrion-avenue; W. Frazer, Esq., M. D., 124, Stephen's-green; A. L. Cousins, Esq., 55, Lower Baggot-street; Stephenson C. Moore, Esq., Kenilworth-villa, were elected members of the Society; and W. Knapp, Esq., Belgrave-square, Monkstown; Edward Doyle, Esq., Martello-terrace; —— Geoghegan, Esq., Carysfort-terrace; J. Russell, Esq.; Richard C. Woodward, Esq., were elected associates for the year 1862-3.

The PRESIDENT read a paper entitled, "Remarks on the Granites of Sweden, Norway, and Finland, as compared with those of Scotland and Donegal;" being an account of a yachting trip to the Baltic, undertaken by him during the past summer, in company with the Commodore of the Mersey Yacht Club.

The meeting then adjourned.

GENERAL MEETING, DEC. 10, 1862.

The PRESIDENT in the Chair.

The Minutes of last meeting were read and confirmed, donations were announced, and thanks voted.

Captain Meadows Taylor, Harold's-cross; Frederick H. Henry, Esq., Lodge-park, Straffan; J. S. Carter, Esq., Wallington-park, Tilsworth, England, were elected members; and Messrs. E. T. Quinton, 25, Leinster-road; J Dickinson, Mountjoy-place; W. H. Wynne, 12, Trinity College; M. H. Ormsby, 16, Fitzwilliam-square, associates for the year 1862-3.

MR. R. H. Scott read a second notice of "The Granitic Rocks of Donegal, and the Minerals therewith associated," being a continuation of that read by him at the opening meeting of the last session (p. 13).

The President said he was sure they had all heard the paper just read with great gratification. The matter of it would not be supposed to be merely of theoretical importance by any person who looked at the beautiful slab of serpentine which lay on the table as a specimen, and which the investigations of the British Association Committee in the western parts of Donegal had been the means of bringing under the notice of persons who he hoped would see the practical use of it.

Mr. J. Beete Jukes said that Mr. Scott's paper had revived in him recollections of the tour which that gentleman, the President, and he himself had the pleasure of making last Easter. He was glad that the district they had traversed had been thus examined before it came under that of the Geological Survey: for it was no part of their business to meddle with minerals—they had only to examine the rocks, and here they had the mineralogy done to their hand. From some things which fell from the President and from Mr. Scott during the progress of their tour, as well as from Dr. Sterry Hunt, as to the later tendencies of geologists, he thought it important at the present day to observe, that while they should give full value to mineralogical investigations, they should be on their guard lest they were led astray by them, for identity of mineral composition did not afford proof of geological identity. Rocks might be bed for bed, variety for variety, the same as to their minerals in Donegal, in Scotland, and in the bed of the St. Lawrence, and yet not be geologically the same rocks at all. With regard to the micaceous conglomerates of which they had some specimens on the table, some persons were disposed to deny that such rocks as mica schist were metamorphic rocks at all, but the occurrence of quartz pebbles in them proved that they were so, and he wished to remind the meeting that rocks similar to these Donegal conglomerates were found in the Alps. The gneiss and mica schist of the Alps were not of the same age as ours at all. There were black slates found in the Alps in immediate connexion with these metamorphic rocks, which contained Belemnites, which, therefore, indicated that the gneiss, &c., was also of secondary age. In South America there were black slates, which were in a certain sense Chalk beds, containing Cretaceous fossils that proved them to be of that period. They must, therefore, be on their guard against jumping to conclusions from such evidence as that which had been adduced that the Donegal beds were contemporaneous with those of the Laurentian series. If rocks of the same general character, but of different age, were subjected to the same metamorphic actions, the result would be to produce similar mica schist and gneiss in both cases. He could bear testimony to the accuracy of Mr. Scott's descriptions, but what evidence had they as to the age of the mica schists of Donegal. Neither they nor the limestones contained any fossils, as he agreed with Mr. Scott that the concretions found near Culdaff were not of organic origin at all. What was found to be the fact about the north and west of Ireland? There was a Carboniferous trough extending up through Leitrim and Armagh into Tyrone. On the south-east side of this they had a series of slates containing double graptolites and other lower Silurian fossils. On the other side of it there were these Donegal mica schists and gneissose beds. It was certainly probable that these were identical beds; those on the south-east side of the Carboniferous trough being unmetamorphosed, and containing fossils, while those on the north-west side of it were metamorphosed into the rocks of which they saw specimens before them. If not, he would ask what had become of the great thickness of Silurian slates, which dipped from the south-east under the Carboniferous basin. As regards the gneiss of the west of Scotland, which had been called Lewisian, or Hebridean, but which Sir R. Murchision was now disposed to call Laurentian, he thought that it was probably contemporaneous with the Laurentian gneiss. It was separated from the over-lying fossiliferous strata, which were themselves of very old date, by another series of beds, with which it was unconformable, and which was itself unconformable with the fossiliferous beds above. In the same way in Canada the Laurentian rocks were separated from the fossiliferous strata by two unconformabilities. Where you had as here three series of rocks, separated by two well-marked gaps, he was disposed to think that there was some geological evidence of identity as to age between the lower members of the group; and he would admit that this was the case, although the rocks were identical in chemical constitution. As to Donegal, he would require much stricter proof than any that had been given to convince him that the metamorphic rocks of Donegal had anything to do with the Laurentian gneiss. He wished to express the most thorough satisfaction with the

mode of investigation which they were pursuing now, because, even supposing it did not prove the chronological identity of the two formations in question, still it led to the acquisition of important, and indeed invaluable information, as to the constitution of the rocks—good sound knowledge of matters of fact, of high importance and interest in themselves, even though it turned out that they were not adequate to bear the great weight of the superstructure of conclusions which might be laid upon them.

The President said he was sure the meeting felt indebted to Mr. Scott, not only for his paper, but also for the very interesting comment which it had drawn from Professor Jukes. He was not quite sure—if his own opinion were called for—whether he should side with Mr. Scott or Professor Jukes. On Professor Jukes' side they had the advantage of connecting the known with the unknown by two great gaps. On Mr. Scott's side they had a number of well-ascertained facts, which, according to Mr. Jukes, had but slight bearing on the question. He had a question to ask Mr. Scott, namely, whether, in the course of his tour, he had found any Rapakivi?

Mr. Scott replied in the negative. However, he had hopes that this rock, so characteristic a feature of the granitic rocks of Finland, might perhaps be found in Scotland. He would remind the meeting that his paper contained no statements as to the absolute age of the Donegal rocks. The area of that county was too small to afford a sufficient district for observation. In his opinion, the battle of the questions involved must be fought in Scotland. As to the structure of the north-west of Ireland, he would remind Mr. Jukes that along the north-west flank of the Carboniferous trough to which he had alluded, Silurian beds did reappear at Pomeroy and Lisbellaw, which at the former locality were separated from the mica schists by a ridge of granite. As regards the value of a mineralogical constitution for determining the age of the Donegal rocks, he was disposed to think that the facts which he had brought forward pointed to something more than a mere accidental coincidence of composition of the strata. This he would point out by an instance taken from the occurrence of the verde antique marble, which was on the table. Dr. T. S. Hunt, when he was in Ireland, at once asked him whether they had not discovered a light-coloured serpentine lying below the dark green serpentine of Aghadoey, near Donegal, and separated from it by a considerable thickness of gneiss and granite. At that time Mr. Scott had only had the specimens for a few days in Dublin, and had not mentioned the discovery of the marble to more than a few persons. Mr. Hunt attached great weight to the differences in chemical constitution between these two beds.

The meeting then adjourned.

General Meeting, January 14, 1863.

The President in the Chair.

The Minutes of last meeting were read and confirmed, donations were announced, and thanks voted.

Thomas W. Kingsmill, Esq., Hong Kong, was elected a corresponding member of the Society.

Mr. E. P. Gribbon, 73, Stephen's-green, architect, was elected a member of the Society.

Professor Jukes then read a paper by Mr. A. B. Wynne, F. G. S., "On the Geology of parts of Sligo" (p. 33).

The President expressed his regret that Mr. Wynne had not been able to assist them at that meeting. He had been promoted to an appointment in which he hoped he would distinguish himself—connected with the geological survey of India. His paper related to a very interesting part of the country, upon which they had had frequent discussions there. Mr. Wynne confined himself very much and very properly to the discussion of the facts which he had observed, leaving to others the discussion of the points which he had not observed. Although his own experience of that county was limited, yet he could confirm the accuracy of Mr Wynne's observations. The large bodies of fossil corals which were so remarkable in that district, had during many years attracted the attention of collectors. Mr. Wynne's sketches were models for the imitation of observers.

Mr. Baily described the fossils collected by Mr. Wynne, which were highly characteristic of the respective strata referred to in the paper.

Mr. Evan Hopkins, F. G. S., observed on the desirability of having correct geological sections, such as would exhibit the connexion between the granitic and fossiliferous rocks. As regarded the latter, it was plain sailing; but there was considerable confusion as to the connexion between them and the granitic rocks.

The President, in calling on the next paper, said that last summer he visited Helsingfors, and he had the pleasure of making the acquaintance of Professor Holmberg, who had charge of the valuable museum of that University. He had just returned from a tour of upwards of four years in Russia, Siberia, and Russian North America; in which he made a magnificent collection of fossils and minerals. The greater part of the Museum of Helsingfors, although it contained foreign specimens, was devoted to a collection of their own minerals; and he never saw a better illustration of what a national museum ought to be. He mentioned to Professor Holmberg that he had been investigating the granites of Finland and Sweden in connexion with those of Scotland and Ireland, and said the Geological Society of Dublin would be most happy to hear his views. Professor Holmberg undertook to communicate them, and had forwarded the sketch about to be read. As he announced at the opening of the session, they would shortly have before them the views of Dr. Sterry Hunt, one of the most advanced of the Canadian geologists, on the question. They were fortunate in having Professor Holmberg's views laid before them on that evening, as they had the advantage of the presence of an English geologist, Mr. Evan Hopkins, who had paid particular attention to the several branches of the question involved.

Mr. R. H. Scott, Hon. Sec., then read Mr. Holmberg's paper—"A Sketch of the Geology of Finland" (p. 41).

The President observed that Professor Holmberg's paper was written in the Swedish language, and it had been translated into English by a gentleman to whom the Society owed many obligations, Dr. W. D. Moore, the celebrated Scandinavian scholar of this city. The Society thanked him for his translation of this paper, without which it would have been inaccessible to them.

Mr. Scott observed that the essential character of Rapakivi had been long known. It was described in 1845 by Professor Gustave Rose, and adduced as evidence of the assertion that oligoclase was of subsequent formation to orthoclase. The rock was well known in boulders, through North Germany, but he believed it only occurred *in situ* at the localities mentioned by Professor Holmberg.

The President observed that by a personal intercourse with Professor Holmberg he learned to know to what kind of rocks he gave the name of gneiss. Helsingfors was situated on a rock which he would have called gneiss, but Professor Holmberg called it granite. There was a specimen of this rock in the museum up-stairs, and it was evident to him that Professor Holmberg confined the term "granite" to slaty-looking rocks, bearing not a very close resemblance to our granites.

Mr. Hopkins made some observations on the connexion between gneiss and granite, and the gradual passage of these rocks one into the other. His statements were founded solely on his own observations in various parts of the world; and he apologized for bringing them before a society to which he was a stranger.

The President stated that the Society was always happy to hear strangers.

Professor Jukes asked was not the Rapakivi on the table the same as a rock which had been seen by the President and himself in Donegal in the beginning of this year? The granites in that district contained both feldspars.

The President said that when he was in St. Petersburg he particularly inquired from his geological friends there what "Rapakivi" was. All the large columns of the Isaac Church, varying from eighty to one hundred and twenty feet in length, were made of the famous "Rapakivi" from Viborg. He found that the definition of this rock employed by the Scandinavian geologists at St. Petersburg quite agreed with his own examination of it. The essential characteristic of the rock was that the feldspar should crystallize in ellipsoidal masses, and that each of the masses should have round it rings of other kinds of feldspar. Mr. Scott was quite correct in saying that the inner part of these rings was always of a potash feldspar, and that the outer part might be of different

kinds of feldspar, with lime, soda—e. g. oligoclase. The spheroidal, and not prismatic, form of the crystallization indicated that the rock was essentially of a metamorphic character, and that it was not igneous. He had not seen the rock *in situ*, but he was satisfied the St. Petersburg mineralogists were right in saying that it was not a genuine igneous rock, for they could not understand how an igneous rock could crystallize in concentric forms. On a small scale, as far as the feldspar was concerned, the specimen shown was like what they saw in the Corsican granite. The word "Rapakivi" was derived from Finnish words signifying "rotten mountain." There were two kinds of it—namely, one which stood exposure to weather extremely well, and to which the name "rotten mountain" was inappropriate; and the other a form disintegrating like China clay, and from which especially the name was derived. In Donegal there was no example of a rock of this sort crystallizing in spheroidal masses.

In the parish of Wederlaks, in the province of Wiborg, in Finland, is situated the celebrated quarry of Pytterlak, which has afforded the material for so many beautiful buildings in the capital of Russia—among others, Alexander's Column. Although the granite there is supposed to be capable of resisting the influence of thousands of years, mineralogists have not been able to find in it anything else than a less weathering variety of Rapakivi. In the neighbourhood of the quarry, on the promontory of Hyvinierni, occur small druses, lined with crystallized fluor spar. In general the Rapakivi granite is characterized by being only extremely rarely accompanied with other minerals. Here, in addition to fluor spar, another exception is met with; for Worth (formerly secretary to the Mineralogical Society in St. Petersburgh) states that he has found yellow Ichthyophthalm, which, however, has not since been met with.

Professor Jukes said—Ireland presented peculiar advantages for the examination of granite, especially in the Leinster district—Gneiss only appeared in a few instances in that province—so few, that Mr. Weaver, in an admirable paper, some years ago, denied the existence of gneiss in Leinster. They had lately, in the Geological Survey, found beds of true gneiss, with mica, feldspar, and quartz. All these rocks, in the district to which he alluded, fade away as the observer recedes from the margin of the granite, and in a space of from a quarter of a mile or two miles entirely disappeared, and the rock gradually passed into the ordinary clay slate of the lower Silurian rocks. He did not know any part of the world where the evidence so clearly proved that it was the intrusion of the granite that converted the ordinary clay slate and the other varieties, including mica schists of various kinds, into gneiss. Here then was granite creating in one way a wholly different class of surrounding rocks. Then came a much more obscure kind of granite, which was met with in Donegal and Mayo, consisting, like the other granite, of crystals of feldspar and mica, and crystalline granules of quartz, in a confused crystalline mass; but showing a gradation from that to the one with flakes of mica and a definite arrangement, or with stratification or lamination—or whatever it was to be called—of a marked character. All this showed that granite was not a rock which was simple in its origin, but might be produced in more ways than one.

Mr. Scott and Mr. Hopkins made some further remarks on the same subject.

The Society then adjourned.

ANNIVERSARY MEETING, FEB. 11, 1863.

The Anniversary Meeting of the Society was held in the New Buildings, Trinity College, at half-past eight o'clock,

The Rev. S. HAUGHTON, M. D., the outgoing President, in the Chair.

Mr. Scott read the Annual Report (p. 48).

The ballot was declared open.

Mr. Cramer Homan, 2, Haddington-road, was elected an associate member of the Society.

The Rev. Professor Jellett moved the adoption of the Report.

Professor Jukes seconded the motion, which passed unanimously.

The ballot was then closed, and Mr. Doyle and Dr. Sidney were appointed scrutineers.

The Chairman said the scrutineers reported that twenty-one members had voted, and that the result of the ballot was the unanimous election of the President and Officers, proposed by the Council (p. 57).

The Chairman said—It is now my duty, and I suppose it is right that I should say my painful duty, to retire from the chair you have done me the honour to place me in for five years; and the pain that I naturally feel on such an occasion, I must confess, is somewhat diminished by a consideration of the gentleman who is to succeed me in this chair. I regret very much that, owing to circumstances which your council foresaw, and that Dr. Lloyd could not possibly avoid, he is not present with us this evening. The death of his brother, Colonel Lloyd, occasioned, I believe, by hardship which he sustained in the shipwreck of the "Colombo," on her return from India, rendered it impossible for our respected Vice-Provost to attend on a particular occasion like this; but he expects to take the earliest opportunity of taking the chair at our meetings, and of showing his interest in the Society. I hold in my hand a letter, which it is not necessary to read, expressing his sense of the honour we have done him in electing him our President. It affords me particular gratification to announce that the Vice-Provost of Trinity College has been elected our President, because some of those present will remember, and all of us have heard of, the obligations which this Society is under to his father, the Rev. Bartholomew Lloyd, Provost of Trinity College. He was, I believe, unquestionably the principal means of founding the Geological Society, thirty-two years ago. The history of the Society may be divided during that thirty-two years into two, as it happens, exactly equal parts. From 1832 to 1848 it met outside the walls of Trinity College, and had an independent existence. It was our habit during that period to meet in rooms supplied by a government office in the Custom-house; but owing to the pressure of the famine which afflicted this country from 1846 to 1848, the Society in 1848 was obliged to change its quarters, and it found a hospitable welcome within the walls of Trinity College. Its council were welcomed and received by our present highly-respected President, the Rev. Humphrey Lloyd. He then placed at our disposal his rooms, and we have occupied them to the present time; so that we are now tenants of them without tenant right, but possessing all the advantages that accrue to the occupier in possession. We do not intend to leave them, and we are not expected to leave them. We therefore owe very great obligations to our President, and to his distinguished father, who preceded him; but I think we may congratulate ourselves on having elected on the present occasion as our President a representative of what may properly be called the exact sciences. Notwithstanding the wonderful progress that geology has made within the last forty or fifty years—a progress greater, I believe, than that which has been made by any science, perhaps, with the exception of chemistry, in an equal period of time—I do not think even the most sensitive geologist will be offended if I say that some of our fundamental principles still require further investigation, sifting, and elucidation. This can only be obtained by the accession to our ranks of observers in the branches of science that are the most exact and precise in their rule. I therefore personally hail with the utmost pleasure and satisfaction, as my successor in this chair, a representative so distinguished as Dr. Lloyd is of the exact sciences. He does not profess to be intimately acquainted with the details of geological science, but he will carry to our midst a precise acquaintance with the details and methods of observation that are found absolutely necessary in other branches of science that have attained a higher perfection than ours has yet done, in consequence of their greater antiquity and the longer time that men's minds have been employed upon them; and I therefore hope that the very best results will arise to the Society from its contact with a mind like his. It would, perhaps, be unsuitable that on the present occasion I should do more than point out in the vaguest and most general manner the branches of geological science that yet remain open to us; but I am led to do so because a few years ago it certainly was the fashion to consider that we had nothing to learn—that our science had arrived at such a state of perfection that, as a very distinguished geologist observed, the work was all done, and future geologists had nothing to do but arrange their museums and collections. Now, as one of those who have passed a good deal of time in arranging museums, I cannot help saying that it would be a very uninteresting occupation for the remainder of geological posterity that they should spend

their whole time in arranging geological collections. I cannot imagir , a purgatory more abominable than that would be. If no idea should ever penetrate the dark caverns of such museums to guide us by the hope of some new discovery, I think the most lamentable consequences would result. However, I believe that in the present state of our science geologists are likely to have a work of a more enlivening character on their hands than the mere labelling of fossils and placing them in proper drawers; and that even the very principles of our science may require to be sifted, laid down with precision, and investigated with care and accuracy. Amongst those principles, one will suggest itself naturally to any member of this Society, for it has been very freely discussed here—I mean the origin of granite. In Werner's time granite was considered, as a matter of course, to be a rock of aqueous origin. The Wernerians were then deposed; and another race of geologists, led by Hutton, succeeded, who held that granite was an igneous rock. Now, I believe the most enlightened member of the Society present would feel himself rather puzzled if he were called on to declare whether granite is aqueous, igneous, or metamorphic (the last being a name ingeniously invented between the other two), for certainly it is one of the three. There are many other questions open to us. Professor Huxley has started a very important question recently, and one that, coming from a person in his position, and speaking with the authority that a zoologist of his attainments must do on such a question, must attract the highest possible attention—namely, the doctrine of characteristic fossils. It appears now, from Professor Huxley's address to the Geological Society of London, that it is at least a question that admits of doubt, whether, when we find a particular fossil in a particular rock, we are entitled to say that that rock is of a certain definite age. The course of ideas that led Professor Huxley to this result can, of course, be best ascertained by reading his address; but it will be readily understood by any one who considers the condition of the living fauna of Australia, and compares it with those of former times. Therefore, this advanced doctrine of characteristic fossils appears to be a question that admits of investigation and examination; and I confess myself I hope the time will never come when in this Society, or in any geological society, any dogma shall be considered as so perfectly established that no person is entitled to question it. We owe our very existence as a society to a protest against received dogmas; and it would be a strange thing if the very prejudice that we complain of so justly against our science should be used by ourselves as a cloak to a prevent any further investigation or inquiry into our principles. For my part, I hope that this Society will always be a free and a fair theatre for the open discussion of every opinion that is put forward on geological subjects, in a gentlemanlike and proper manner, as I have no doubt will always be the case. In resigning, gentlemen, the office that you have done me the honour to confide to me for five years in succession to such a distinguished successor, I may be allowed to add a word, in conclusion, to what has been already said by your council more effectively than I can say it, as to the losses that we have sustained during the past year. The death of the late Vice-Provost of this College, the Rev. Dr. Wall, was more a collegiate loss than a loss to us as a society. He did not take much part in our meetings; but from his character, his great age, and his well-known hospitality, so well appreciated by every class in the community, I think I only express the unanimous feeling of the educated public of Dublin when I say that any society to which he belonged must have felt his death to be a very great loss. With regard to the more recent loss of Dr. Kinahan, I can only say that I sympathize fully and completely in what has been expressed by the statement of the council. Dr. Haughton here paid a high tribute to the moral and intellectual character of the late Dr. Kinahan, who had been his pupil in College. All competent to form an opinion on the subject would agree that by his death Dublin and Ireland had sustained a most serious loss. He was, unquestionably, the most original of all our naturalists. He was endowed with that power of observing nature in the field, which, apart from book knowledge, was the chief essential of a naturalist; and he had never met a person in whom honour, truthfulness, and integrity, were more highly developed. Dr. Haughton concluded by again expressing his sense of the honour the Society had conferred in electing him President during five successive years. He resigned the office leaving the Society prosperous and with a good exchequer; and he felt a pleasure in vacating the chair in favour of such a man as Dr. Lloyd, who was so much more worthy to occupy it than he was. Dr. Haughton then requested Mr. Jukes to take the chair in the absence of Dr. Lloyd.

Mr. Jukes, having taken the chair, said—I will not attempt to add my opinion a to the qualifications of our new President. It would be absurd on my part to do so Many things have been said by your now retiring President in which I most cordially join, and on which, if the hour were earlier, I should have been glad to say a few words, more especially on the subject of the death of the late Dr. Kinahan. I must, however, ask to say a few words in reference to Dr. Haughton himself, I think I need hardly say much, at all events, to remind you of his merits, and of the admirable manner in which he filled the chair for five years. During that period he has been the great spirit and the life of our Society. He has been the great spirit which kept us alive, not only by his great researches, which he might have brought before us as a private member, but also by the way in which he filled the chair, and the genial spirit which he diffused amongst us all. I will not detain you longer by attempting to state his merits; and I have not the least doubt that some one amongst you will move a formal vote of thanks to him for the way in which he filled the office of President.

Mr. Callwell said he had great pleasure in moving the thanks of the Society to Dr. Haughton for the admirable manner in which he had filled the office of President of the Society for the last five years.

The Rev. Professor Jellett, in seconding the motion, said—Although I cannot take upon myself the name of a geologist in any sense of the word, yet I second the motion with pleasure, and I think it no small proof of the range of our late President's abilities that I should be able to do so. Mr. Haughton's abilities have not been confined to the geological field. In the more exact, because, as he has said, the older sciences, with which I am myself more conversant, I know how much he has done; and I know what assistance I myself have received, as well as what I suppose it is the experience of every one who has been engaged along with him in scientific investigations, to have received from him. I am quite sure that, in bringing to the study of geology that acquaintance with the exact sciences which he has brought, he conferred upon the science of geology a very great advantage. No science can thrive long which does not borrow from the more exact sciences their severe and accurate logic. I am very happy. that our new President is also a man distinguished in the more exact sciences, as Mr. Haughton has been. I think the Council exercised a wise discretion in enlarging the field from which they took those who are to preside over this Society. I have no doubt that in our Vice-Provost the Geological Society will find a worthy successor to our late President; and I am sure every one will agree that I cannot say more for him than that.

The Chairman called on the meeting to pass the vote by acclamation, which having been done, the meeting was adjourned.

VIII.—On the Chemical and Mineralogical Relations of Metamorphic Rocks. By T. Sterry Hunt, F. R. S., of the Geological Survey of Canada.

[Read April 8, 1863.]

At a time not very remote in the history of geology, when all crystalline stratified rocks were included under the common designation of primitive, and were supposed to belong to a period anterior to the fossiliferous formations, the lithologist confined his studies to descriptions of the various species of rocks, without reference to their stratigraphical or geological distribution. But with the progress of geological science, a new problem was presented to his investigation. While palæontology has shown that the fossils of each formation furnish a guide to its age and stratigraphical position, it has been found that sedimentary strata of all ages, up to the tertiary, inclusive, may undergo such changes as to obliterate the direct evidences of organic life, and to give to the sediments the mineralogical characters once assigned to primitive rocks. The question here arises, whether, in the absence of organic remains, or of stratigraphical evidence, there exists any means of determining, even approximately, the geological age of a given series of crystalline stratified rocks;—in other words, whether the chemical conditions which have presided over the formation of sedimentary rocks have so far varied, in the course of ages, as to impress upon these rocks marked chemical and mineralogical differences. In the case of unaltered sediments it would be difficult to arrive at any solution of this question without greatly multiplied analyses; but in the same rocks, when altered, the crystalline minerals which are formed, being definite in their composition, and varying with the chemical constitution of the sediments, may, perhaps, to a certain extent, become to the geologist what organic remains are in the unaltered rocks, a guide to the geological age and succession.

It was while engaged in the investigation of metamorphic rocks of various ages in North America, that this problem suggested itself, and I have endeavoured from chemical considerations, conjoined with multiplied observations, to attempt its solution. In the "American Journal of Science" for 1858, and in the "Quarterly Journal of the Geological Society of London" for 1859 (p. 488), will be found the germ of the ideas on this subject which I shall endeavour to explain in the present paper. It cannot be doubted that in the earlier periods of the world's history, chemical forces of certain kinds were much more active than at the present day. Thus, the decomposition of earthy and alkaline silicates, under the combined influence of water and carbonic acid, would be greater when this acid gas was more abundant in the atmosphere, and the temperature probably higher. The larger amounts of alkaline and earthy carbonates then carried to the sea, from the decomposition of these silicates, would furnish a greater amount of calcareous matter to

the sediments; and the chemical effects of vegetation, both on the soil and on the atmosphere, must have been greater during the Carboniferous period, for example, than at present. In the spontaneous decomposition of feldspars, which may be described as silicates of alumina, combined with silicates of potash, soda, and lime, these latter bases are removed, together with a portion of silica; and there remains, as the final result of the process, a hydrous silicate of alumina, which constitutes kaolin or clay. This change is favoured by mechanical division; and Daubrée has shown that by prolonged attrition of fragments of granite under water, the softer and readily cleavable feldspar is in great part reduced to an impalpable powder, while the uncleavable grains of quartz are only rounded, and form a readily subsiding sand—the water at the same time dissolving from the feldspar a certain portion of silica and of alkali. It has been repeatedly observed, that where potash and soda feldspar are associated, the latter is much the more readily decomposed, becoming friable, and finally being reduced to clay, while the orthoclase is unaltered. The result of combined chemical and mechanical agencies acting upon rocks which contain quartz, with orthoclase, and a soda felspar, such as albite or oligoclase, would thus be a sand made up chiefly of quartz and potash feldspar, and a finely divided and suspended clay, consisting for the most part of kaolin and of partially decomposed soda feldspar, mingled with some of the smaller particles of orthoclase and of quartz. With this sediment will also be included the oxide of iron, and the earthy carbonates set free by the sub-aërial decomposition of silicates like pyroxene and the lime feldspars, or formed by the action of the carbonate of soda derived from the latter upon the lime and magnesia salts of sea water. The debris of hornblende and pyroxene will also be found in this finer sediment. This process is evidently the one which must go on in the wearing away of rocks by aqueous agency, and explains the fact that while quartz, or an excess of combined silica, is for the most part wanting in rocks which contain a large proportion of alumina, it is generally abundant in those in which potash feldspar predominates.

So long as this decomposition of alkaliferous silicates is sub-aërial, the silica and alkali are both removed in a soluble form. The process is often, however, submarine, or subterranean, taking place in buried sediments which are mingled with carbonates of lime and magnesia. In such cases the silicate of soda set free, reacts either upon these earthy carbonates, or upon the corresponding chlorides of the sea water, and forms in either event a soluble soda salt, and an insoluble silicate of lime and magnesia, which takes the place of the removed silicate of soda. The evidence of such a continued reaction between alkaliferous silicates and earthy carbonates is seen in the large amounts of carbonate of soda, with but little silica, which infiltrating waters constantly remove from argillaceous strata; thus giving rise to alkaline springs, and to natron lakes. In these waters it will be found that soda greatly predominates, sometimes almost to the exclusion of potash. This is due not only to the fact that soda feldspars are more readily decomposed

than orthoclase, but to the well-known power of argillaceous sediments to abstract from water the potash salts which it already holds in solution. Thus, when a solution of silicate, carbonate, sulphate, or chloride of potassium is filtered through common earth, the potash is taken up, and replaced by lime, magnesia, or soda, by a double decomposition between the soluble potash salt and the insoluble silicates of the latter bases. Soils in like manner remove from infiltrating waters, ammonia, and phosphoric and silicic acids, the bases which were in combination with these being converted into carbonates. The drainage water of soils, like that of most mineral springs, contains only carbonates, chlorides, and sulphates of lime, magnesia, and soda—the ammonia, potash, phosphoric and silicic acids being retained by the soil.

The elements which the earth retains or extracts from waters are precisely those which are removed from it by growing plants. These, by their decomposition under ordinary conditions, yield their mineral matters again to the soil; but when decay takes place in water, these elements become dissolved, and hence the waters from peat bogs and marshes contain large amounts of potash and of silica in solution, which are carried to the sea, there to be separated; the silica by protophytes, and the potash by algæ, which latter, decaying on the shore, or in the ooze at the bottom, restore the alkali to the earth. The conditions under which the vegetation of the coal formation grew and was preserved, being similar to those of peat, the soils became exhausted of potash, and are seen in the fire-clays of that period.

Another effect of vegetation on sediments is due to the reducing or deoxidizing agency of the organic matters from its decay. These, as is well known, reduce the peroxide of iron to a soluble protoxide, and remove it from the soil, to be afterwards deposited in the forms of iron ochre and ores, which by subsequent alteration became hard, crystalline and insoluble. Thus, through the agency of vegetation, is the iron oxide of the sediments withdrawn from the terrestrial circulation; and it is evident that the proportion of this element diffused in the more recent sediments must be much less than in those of ancient times. The reducing power of organic matter is farther shown in the formation of metallic sulphurets; the reduction of sulphates having precipitated in this insoluble form the heavy metals, copper, lead, and zinc, which, with iron, appear to have been in solution in the waters of early times, but are now by this means also abstracted from the circulation, and accumulated in beds and fahlbands, or by a subsequent process have been redissolved and deposited in veins. All analogies lead us to the conclusion that the primeval condition of the metals, and of sulphur, was, like that of carbon, one of oxidation, and that vegetable life has been the sole medium of their reduction.

The source of the carbonates of lime and magnesia in sedimentary strata is two-fold:—first, the decomposition of silicates containing these bases, such as lime feldspar and pyroxene; and, second, the action of the alkaline carbonates formed by the decomposition of feldspars, upon the chlorides of calcium and magnesium originally present in sea-water,

which have thus, in the course of ages, been in great part replaced by chloride of sodium. The clay or aluminous silicate which has been deprived of its alkali is thus a measure of the carbonic acid removed from the air, of the carbonates of lime and magnesia precipitated, and of the amount of chloride of sodium added to the waters of the primeval ocean.

The coarser sediments, in which quartz and orthoclase prevail, are readily permeable to infiltrating waters, which gradually remove from them the soda, lime, and magnesia, which they contain; and if organic matters intervene, the oxide of iron; leaving at last little more than silica, alumina, and potash; the elements of granite, trachyte, gneiss, and mica schist. On the other hand, the finer marls and clays, resisting the penetration of water, will retain all their soda, lime, magnesia, and oxide of iron, and containing an excess of alumina, with a small amount of silica, will, by their metamorphism, give rise to basic lime and soda feldspars, and to pyroxene and hornblende—the elements of diorites and dolerites. In this way, the operation of the chemical and mechanical causes which we have traced naturally divides all the crystalline silico-aluminous rocks of the earth's crusts into two types. These correspond to the two classes of igneous rocks, distinguished first by Professor Phillips, and subsequently by Durocher and by Bunsen, as derived from two distinct magmas, which these geologists imagine to exist beneath the solid crust, and which the latter denominates the trachytic and pyroxenic types. I have, however, elsewhere endeavoured to show that all intrusive or exotic rocks are probably nothing more than altered and displaced sediments, and have thus their source within the lower portions of the stratified crust, not beneath it.

It may be well in this place to make a few observations on the chemical conditions of rock metamorphism. I accept in its widest sense the view of Hutton and of Boué, that all the crystalline stratified rocks have been produced by the alteration of mechanical and chemical sediments. The conversion of these into definite mineral species has been effected in two ways: first, by molecular changes, that is to say, by crystallization, and a rearrangement of the particles; and, secondly, by chemical reactions between the elements of the sediments. Pseudomorphism, which is the change of one mineral species into another, by the introduction or the elimination of some element or elements, presupposes metamorphism; since only definite mineral species can be the subjects of this process. To confound metamorphism with pseudo-morphism, as Bischoff, and others after him, have done, is therefore an error. It may be farther remarked, that although certain pseudomorphic changes may take in some mineral species, in veins, and near to the surface, the alteration of great masses of silicated rocks by such a process is as yet an unproved hypothesis.

The cases of local metamorphism in proximity to intrusive rocks go far to show, in opposition to the views of certain geologists, that heat has been one of the necessary conditions of the change. The source of this has been generally supposed to be from below; but to the hypothe-

sis of alteration by ascending heat, Naumann has objected that the inferior strata in some cases escape change; and that, in descending, a certain plane limits the metamorphism, separating the altered strata above from the unaltered ones beneath; there being no apparent transition between the two. This, taken in connexion with the well-known fact that in many cases the intrusion of igneous rocks causes no apparent change in the adjacent unaltered sediments, shows that heat and moisture are not the only conditions of metamorphism. In 1857, I showed by experiments, that, in addition to these conditions, certain chemical reagents might be necessary, and that water, impregnated with alkaline carbonates and silicates, would, at a temperature not above that of 212° F., produce chemical reactions among the elements of many sedimentary rocks, dissolving silica, and generating various silicates.* Some months subsequently, Daubrée found that in the presence of solutions of alkaline solutions, at temperatures above 700° F., various siliceous minerals, such as quartz, feldspar, and pyroxene, could be made to assume a crystalline form; and that alkaline silicates in solution at this temperature might combine with clay to form feldspar and mica.† These observations were the complement of my own, and both together showed the agency of heated alkaline waters to be sufficient to effect the metamorphism of sediments by the two modes already mentioned—namely, by molecular changes, and by chemical reactions. Following upon this, Daubrée observed that the thermal alkaline spring of Plombieres, with a temperature of 160° F. had, in the course of centuries, given rise to the formation of zeolites, and other crystalline silicated minerals, among the bricks and cement of the old Roman baths. From this he was led to suppose that the metamorphism of great regions might have been effected by hot springs, which, rising along certain lines of dislocation, and thence spreading laterally, might produce alteration in strata near to the surface, while those beneath would in some cases escape change.‡ This ingenious hypothesis may serve in some cases to meet the difficulty pointed out by Naumann; but while it is un-

* "Proc. Royal Soc. London," May 7, 1857, and "Philos. Mag." (4) xv., 68; also "Amer. Jour. Science" (2), xxii., 437, and xxv., 435.

† "Comptes Rendus de l'Acad.," Nov. 16, 1857; also "Bull. Soc. Geol. France" (2), xv., 103.

‡ It should be remembered that normal or regional metamorphism is in no way dependent upon the proximity of unstratified or igneous rocks, which are rarely present in metamorphic districts. The ophiolites, amphibolites, euphotides, diorites, and granites of such regions, which it has been customary to regard as exotic or intrusive rocks, are in most cases indigenous, and are altered sediments. I have elsewhere shown that the great outbursts of intrusive dolerites, diorites, and trachytes in south-eastern Canada are found, not among the metamorphic rocks, but among the unaltered strata along their margin, or at some distance removed; and I have endeavoured to explain this by the consideration that the great volume of overlying sediments, which, by retaining the central heat, aided in the alteration of the now denuded strata, produced a depression of the earth's surface, and forced out the still lower and softened strata along the lines of fracture which took place in the regions beyond. See my paper "On some Points in American Geology," "Amer. Jour. Science" (2), xxxi., 414.

doubtedly true in certain instances of local metamorphism, it seems to be utterly inadequate to explain the complete and universal alteration of areas of sedimentary rocks, embracing many hundred thousands of square miles. On the other hand, the study of the origin and distribution of mineral springs shows that alkaline waters (whose action in metamorphism I first pointed out, and whose efficient agency Daubrée has since so well shown), are confined to certain sedimentary deposits, and to definite stratigraphical horizons; above and below which saline waters wholly unlike in character are found impregnating the strata. This fact seems to offer a simple solution of the difficulty advanced by Naumann, and a complete explanation of the theory of metamorphism of deeply buried strata by the agency of ascending heat; which is operative in producing chemical changes only in those strata in which soluble alkaline salts are present.*

When the sedimentary strata have been rendered crystalline by metamorphism, their permeability to water, and their alterability, become greatly diminished; and it is only when again broken down by mechanical agencies to the condition of soils and sediments, that they once more become subject to the chemical changes which have just been described. Hence, the mean composition of the argillaceous sediments of any geological epoch, or, in other words, the proportion between the alkalies and the alumina, will depend not only upon the age of the formation, but upon the number of times which its materials have been broken up, and the periods during which they have remained unmetamorphosed and exposed to the action of infiltrating waters. Thus, for example, that portion of the Lower Silurian rocks in Canada which became metamorphosed before the close of the Palæozoic period will have lost much less of its soluble bases, than the portion of the same age which still remains in the form of unaltered shales and sandstones. Of these, again, such portions as remain undisturbed by folds and dislocations, will retain a larger portion of bases, than those strata in which such disturbances have favoured the formation of mineral springs; which, even now, are active in removing soluble matters from these rocks. The crystalline Lower Silurian rocks in Canada may be compared with those of the older Laurentian series on the one hand, and with the Upper Silurian or Devonian on the other; but when these are to be compared with the crystalline strata of secondary or tertiary age in the Alps, it cannot be determined whether the sediments of which these were formed (and which may be supposed, for illustration, to have been directly derived from Palæozoic strata), existed up to the time of their translation, in a condition similar to that of the altered or the unaltered Lower Silurian rocks of Canada. The proportion between the alkalies

* See "Report of the Geological Survey of Canada, 1853-6," pp. 479, 480; also "Canadian Naturalist," vol. vii., p. 262. For a consideration of the relations of mineral waters to geological formations, see "General Report on the Geology of Canada" (now in the press), p. 61; also chap. xix. on "Sedimentary and Metamorphic Rocks;" where most of the points touched in the present paper are discussed at greater length.

and the alumina in the argillaceous sediments of any given formation is not, therefore, in direct relation to its age, but indicates the extent to which these sediments have been subjected to the influences of water, carbonic acid, and vegetation. If, however, it may be assumed that this action, other things being equal, has, on the whole, been proportionate to the newness of the formation, it is evident that the chemical and mineralogical composition of different systems of rocks must vary with their antiquity, and it now remains to find in their comparative study a guide to their respective ages.

It will be evident that siliceous deposits, and chemical precipitates, like the carbonates and silicates of lime and magnesia, may exist with similar characters in the geological formations of any age; not only forming beds apart, but mingled with the impermeable silico-aluminous sediments of mechanical origin. Inasmuch as the chemical agencies giving rise to these compounds were then most active, they may be expected in greatest abundance in the rocks of the earlier periods. In the case of the permeable and more highly siliceous class of sediments already noticed, whose chief elements are silica, alumina, and alkalies, the deposits of different ages will be marked chiefly by a progressive diminution in the amount of potash, and the disappearance of the soda which these contain. In the oldest rocks the proportion of alkali will be nearly or quite sufficient to form orthoclase and albite with the whole of the alumina present; but as the alkali diminishes, a portion of the alumina will crystallize, on the metamorphism of the sediments, in the form of a potash-mica, muscovite, or margarodite. While the oxygen ratio between the alumina and the alkali in the feldspars just named is 3 : 1, it becomes 6 : 1 in margarodite, and 12 : 1 in muscovite. The appearance of these micas in a rock then denotes a diminution in the amount of alkali, until in some strata the feldspar almost entirely disappears, and the rock becomes a quartzose mica schist. In sediments still farther deprived of alkali, metamorphism gives rise to schists filled with crystals of kyanite, and andalusite, simple silicates of alumina, into whose composition alkalies do not enter; or, in case the sediment still retains oxide of iron, staurotide and iron-alumina garnet take their place. The matrix of all these minerals is generally a quartzose mica schist. The last term in this exhaustive process appears to be represented by the disthene and pyrophyllite rocks, which occur in some regions of crystalline schists.

In the second class of sediments we have alumina in excess, with a small proportion of silica, and a deficiency of alkali, besides a variable proportion of silicates or carbonates of lime, magnesia, and oxide of iron. The result of the processes already described will produce a gradual diminution in the amount of alkali, which is chiefly soda. So long as this predominates, the metamorphism of these sediments will give rise to feldspars like oligoclase, labradorite, or scapolite (a dimetric feldspar); but in sediments where lime replaces a great proportion of the soda, there appears a tendency to the production of denser silicates, like lime-alumina, garnet, and zoisite, which replace the soda-lime feldspars. Minerals like the chlorites, and chloritoid, are formed when magnesia and

iron replace lime. In all these cases the excess of the silicates of earthy protoxides over the silicate of alumina is represented in the altered strata by hornblende, pyroxene, olivine, and similar species; which give rise, by their admixture with the double aluminous silicates, to diorite, dolerite, diabase, euphotide, eklogite, and similar compound rocks.

In Eastern North America the crystalline strata, so far as yet studied, may be conveniently classed in five groups, corresponding to as many different geological series, four of which will be considered in the present paper.

I. The Laurentian system represents the oldest known rocks of the globe, and is supposed to be the equivalent of the Primitive Gneiss formation of Scandinavia, and that of the Western Islands of Scotland; to which also the name of Laurentian is now applied. It has been investigated in Canada along a continuous outcrop from the coast of Labrador to Lake Superior, and also over a considerable area in northern New York.

II. Associated with this system is a series of strata characterized by a great development of anorthosites, of which the hypersthenite, or opalescent feldspar rock of Labrador, may be taken as a type. These strata overlie the Laurentian gneiss, and are regarded as constituting a second or more recent group of crystalline rocks, to which the name of the Labrador series may be provisionally given. From evidence recently obtained, Sir William Logan conceives it probable that this series is unconformable with the older Laurentian system, and probably separated from it by a long interval of time.

III. In the third place is a great series of crystalline schists, which are in Canada referred to the Quebec group, the inferior part of the Lower Silurian system. They appear to correspond both lithologically and stratigraphically with the schistose group of the Primitive Slate formation of Norway, as recognised by Naumann and Keilhau, and to be there represented by the strata in the vicinity of Drontheim, and of the Dofrefeld. The Huronian series of Canada, in like manner, appears to correspond to the Quartzose group of the same Primitive Slate formation. It consists of sandstones, imperfect varieties of gneiss, diorites, siliceous and feldspathic schists passing into argillites, with limestones, and great beds of hæmatite. Though more recent than the Laurentian and Labrador series, these strata are older than the Quebec group; yet, from their position to the westward of the greatest accumulation of sediments, they have been subjected to a less complete metamorphism than the palæozoic strata of the east. The Huronian series is as yet but imperfectly studied, and for the present will not be further considered.

IV. In the fourth place are to be noticed the metamorphosed strata of Upper Silurian and Devonian age, with which may also be included those of the Carboniferous system in eastern New England. This group has as yet been imperfectly studied, but presents interesting peculiarities.

In the oldest of these, the Laurentian system, the first class of aluminous rocks takes the form of granitoid gneiss, which is often coarse-

grained and porphyritic. Its feldspar is frequently a nearly pure potash orthoclase, but sometimes contains a considerable proportion of soda. Mica is often almost entirely wanting, and is never abundant in any large mass of this gneiss, although small bands of mica schist are occasionally met with. Argillites, which, from their general predominance of potash and of silica, are related to the first class of sediments, are, so far as known, wanting throughout the Laurentian series; nor is any rock here met with which can be regarded as derived from the metamorphism of sediments, like the argillites of more modern series. Chloritic and chiastolite schists, and kyanite, are, if not altogether wanting, extremely rare in the Laurentian system. The aluminous sediments of the second class are however represented in this system by a diabase made up of dark green pyroxene and bluish labradorite, often associated with a red alumino-ferrous garnet. This latter mineral also sometimes constitutes small beds, often with quartz, and occasionally with a little pyroxene. These basic aluminous minerals form, however, but an insignificant part of the mass of strata. This system is further remarkable by the small amount of ferruginous matter diffused through the strata; from which the greater part of the iron seems to have been removed, and accumulated in the form of immense beds of hæmatite and magnetic iron. Beds of pure crystalline plumbago also characterize this series, and are generally found with the limestones. These are here developed to an extent unknown in more recent formations, and are associated with beds of crystalline apatite, which sometimes attain a thickness of several feet. The serpentines of this series, so far as yet studied in Canada, are generally pale coloured, and contain an unusual amount of water, a small proportion of oxide of iron, and neither chrome nor nickel, both of which are almost always present in the serpentines of the third series.

The second, or Labrador series, is characterized, as already remarked, by the predominance of great beds of anorthosite, composed chiefly of triclinic feldspars, which vary in composition from anorthite to andesine. These feldspars sometimes form mountain masses almost without any admixture; but at other times include portions of pyroxene, which passes into hypersthene. Beds of nearly pure pyroxenite are met with in this series, and others which would be called hyperite and diabase. These anorthosite rocks are frequently compact, but are more often granitoid in structure. They are generally greyish, greenish, or bluish in colour, and become white on the weathered surfaces. The opalescent labradorite rock of Labrador is a characteristic variety of these anorthosites, which often contain small portions of red garnet and brown mica, and more rarely epidote and a little quartz. They are sometimes a little calcareous. Magnetic iron and ilmenite are often disseminated in these rocks, and occasionally form masses or beds of considerable size. These anorthosites constitute the predominant part of the Labrador series, so far as yet examined. They are, however, associated with beds of quartzose orthoclase gneiss, which represent the first class of aluminous sediments, and with crystalline limestones; and they will probably be found, when further studied, to offer a complete lithological series. These rocks

have been observed in several areas among the Laurentide Mountains, from the coast of Labrador to Lake Huron, and are also met with among the Laurentian rocks of the Adirondack Mountains, of which, according to Emmons, they form the highest summits.

In the third series, which we have referred to the Lower Silurian age, the gneiss is sometimes granitoid, but less markedly so than in the first; and it is much more frequently micaceous, often passing into a micaceous schist; a common variety of which contains disseminated a large quantity of chloritoid. Argillites abound, and under the influence of metamorphism sometimes develop crystalline orthoclase. At other times they are converted into a soft micaceous mineral, and form a kind of mica schist. Chiastolite and staurotide are never met with in the schists of this series, at least in its northern portions, throughout Canada and New England. The anorthosites of the Labrador series are represented by fine-grained diorites, in which the feldspar varies from albite to very basic varieties, which are sometimes associated with an aluminous mineral allied to chlorite in composition. Chloritic schists, frequently accompanied by epidote, abound in this series. The great predominance of magnesia in the forms of dolomite, magnesite, steatite, and serpentine, is also characteristic of portions of this series. The latter, which forms great beds (ophiolite), is marked by the almost constant presence of small portions of the oxides of chrome and nickel. These metals are also common in the other magnesian rocks of the series; chrome-green garnets and chrome mica occur; and beds of chrome ore are found in the ophiolites of the series. It is also the gold-bearing formation of eastern North America, and contains large quantities of copper ores in interstratified beds resembling those of the Permian schists of Mansfeld and Hesse. In some parts of this series pure limestones occur, which contain various crystalline minerals common also to the Laurentian limestones, and to those of the fourth series. The only graphite which has been found in the third series is in the form of impure plumbaginous shales.

The metamorphic rocks of the fourth series, as seen in south-eastern Canada, are, for the greater part, quartzose and micaceous schists, more or less feldspathic; which in the neighbouring States become remarkable for a great development of crystals of staurotide and of red garnet. A large amount of argillite occurs in this series; and when altered, whether locally by the proximity of intrusive rock, or by normal metamorphism, exhibits a micaceous mineral and crystals of andalusite, so that it becomes known as chiastolite slate in its southern extension. Granitoid gneiss is still associated with these crystalline schists. Gold is not confined to the third series, but is also met with in veins cutting the argillites of Upper Silurian age. The crystalline limestones and ophiolites of eastern Massachusetts, which are probably of this age, resemble those of the Laurentian system; and the coal beds in that region are, in some parts, changed into graphite. It is to be remarked that the metamorphic strata of the third and fourth series are contiguous throughout their extent, so far as examined, but are everywhere separated from the Laurentian by a zone of unaltered Palæozoic rocks.

Large masses of intrusive granite occur among the crystalline strata of the fourth series, but are rare or unknown among the older metamorphic rocks in Canada. The so-called granites of the Laurentian and Lower Silurian appear to be in every case indigenous rocks, that is to say, strata altered *in situ*, and still retaining evidences of stratification. The same thing is true with regard to the ophiolites of both series, and the anorthosites; in all of which the general absence of great masses of unstratified rock is especially noticeable. No evidences of the hypothetical granitic substratum are met with in the Laurentian system, although this is in one district penetrated by great masses of syenite, orthophyre, and dolerite. Granitic veins, with minerals containing the rarer elements, such as boron, fluorine, lithium, zirconium, and glucinum, are met with alike in the oldest and the newest gneiss in North America. These, however, I regard as having been formed, like metalliferous veins, by aqueous deposition in fissures in the strata.

The above observations upon the metamorphic strata of a wide region seem to be in conformity with the chemical principles already laid down in this paper; which it remains for geologists to apply to the rocks of other regions, and thus determine whether they are susceptible of a general application. I have found that the blue crystalline labradorite of the Labrador series of Canada is exactly represented by specimens from Scarvig, in Skye; and the ophiolites of Iona resemble those of the Laurentian series in Canada. Many of the rocks of Donegal appear to me lithologically identical with those of the Laurentian period; while the serpentines of Aghadoey, containing chrome and nickel, and the andalusite and kyanite schists of other parts of Donegal, cannot be distinguished from those which characterize the altered Palæozoic strata of America. It is to be remarked that chrome and nickel-bearing serpentines are met with in the same geological horizon in Canada and Norway; and that those of the Scottish Highlands, which contain the same elements, belong to the newer gneiss formation; which, according to Sir Roderick Murchison, would be of similar age. The serpentines of Cornwall, the Vosges, Monte Rosa, and many other regions, agree in containing chrome and nickel; which, on the other hand, seem to be absent from the serpentines of the primitive gneiss formation of Scandinavia. It remains to be determined how far chemical and mineralogical differences, such as those which have been here indicated, are geological constants. Meanwhile it is greatly to be desired that future chemical and mineralogical investigations of crystalline rocks should be made with this question in view; and that the metamorphic strata of the British Isles, and the more modern ones of Southern and Central Europe, be studied with reference to the important problem which it has been my endeavour, in the present paper, to lay before the Society.

Montreal, Canada, Jan. 25, 1863.

IX.—On some Striated Surfaces in the Granite near Dublin. By the Rev. Maxwell Close, B. A.

[Read May 13, 1863.]

In the granite in the neighbourhood of Dublin are to be seen a great number of surfaces—I believe always joint surfaces—which exhibit striations more or less distinctly marked.* The striations vary considerably in character, and yet seem to be nearly related to one another, as will appear in what follows.

Some of these striated surfaces are pointed out to us by the Irish Geological Survey in the explanations of Sheet 112 of the maps of the Survey. There they are spoken of as "slickensides;" and to this designation many of them are most justly entitled, if that term be used as simply descriptive of a certain kind of phenomenon. Some of these surfaces are, as to their smoothness and striation, remarkably similar to some galena slickenside surfaces. I believe that an accurate cast of one or two of the specimens now exhibited would not be distinguishable from a like cast of certain galena slickensides that I have seen.

But, before proceeding to speak particularly of our theme, the striated granite surfaces in this neighbourhood, I would beg permission to draw attention to something suggested by the examination of them, which is that the whole subject of slickensides is still in a very unsatisfactory state. This is, of course, no new discovery; it has doubtless been felt by many; but still it seems to be often ignored, and therefore it may be of use to draw attention pointedly to the fact.

Etymologically, the term "slickensides" is simply a description of a phenomenon; it involves no theory, no reference to the cause of the phenomenon. Some geologists use it in this way, and apply it to different surfaces, whose striations are, as they themselves believe, due to very different causes. They have a right to do this, provided they inform us of it, and distinguish between different kinds of slickensides. But some restrict the application of the term to those surfaces which they suppose to have been striated and smoothed by friction, caused by the movement of one mass of rock upon another. And they have a right to do this, if they make us aware of it. It is, doubtless, inconvenient that there should be these different usages of the word; still there is not involved in either any necessary error as to facts. But sometimes we meet with an uncritical employment of the name of slickensides, which may, and I believe sometimes does, lead to error. It is, of course, no matter of complaint that two geologists should differ as to whether a particular striated surface is or is not the result of movement. This

* Similar striations occur in the Cambrian rocks at Bray Head, and in the metamorphic Silurian slates which border the granite.

may be unavoidable in the present state of our knowledge; but it is to be deprecated that the usage of the term in question should vary, and that there should be sometimes a want of discrimination in the application of it. It seems to be desirable that the difficulties of the matter, and the fact that great differences of opinion exist concerning it, should be more fully recognised.

Take, for instance, a galena slickenside surface. Those who would agree in ascribing its peculiar character to the movement on each other of the cheeks of the containing fissure, will differ very widely in their accounts of the precise process of formation. One theory is, that the cheeks of the fissure have first, during their movement, striated and smoothed each other by friction, and that then the galena was deposited upon them, taking their form. The smoothness of the galena would thus be an impression of a true *polish*. Some account for the character of a galena slickenside surface by the clay-like softness of some of the parts at the time of the movement. This would make the smoothness to be comparable to the *slab sleekness* of mortar after the trowel. Whether it was impressed directly or not on the galena does not signify for our present purpose. Another theory is, that the rubbing was between two already deposited galena surfaces, and that these, from their metallic nature, would impart to each other the shining smoothness without much necessary abrasion. This would make the smoothness to be more properly a *burnish*. If I might be allowed to express an opinion, I should say that this explanation seems the best of the three; but then it is very special, and leaves us to account for other smooth striated surfaces as best we may. It is next door to an acknowledgment that other rock materials would not polish themselves by friction. One geologist ascribes the striations of slickenside surfaces (in general) to friction, and the smoothness (apparently) to an after-deposited *glaze*. Here we have the same acknowledgment. But this last explanation of the matter would be quite inapplicable to galena slickensides; and, moreover, it is accounting for a very common phenomenon by the accidental concurrence of two totally unconnected causes.

The special explanations that are often given of different supposed rubbed surfaces are often not only inapplicable to other surfaces (which may be proper enough), but sometimes, to some extent, contravene each other. The general *consensus* of those who ascribe the slickenside phenomenon to the action of movement seems to be very imposing; but its weight is considerably diminished when we find such discordance as to details. Agreement as to the agent avails little, if there be such difficulty in applying the agent. The result is, that some are tempted to doubt whether even a galena slickenside face could be produced by movement at all.*

* The varied character of galena slickensides, and the peculiarities of some of them, seem to confirm this doubt. There is a class of this phenomenon which must be undoubtedly due to movement taking place in a squeezing, sliding manner among masses

The subject is important on account of its connexion with the deposition of the mineral contents of veins, among which the phenomenon in question so often occurs; but also for another reason.

Phillips says ("Manual of Geology")—"We may perhaps eventually draw from examinations of this phenomenon in connexion with, and apart from, mineral veins, some decisive results as to the time and other circumstances connected with the movement of the masses." And Delabeche says ("Geological Observer")—"When movements have been considerable (in veins), a polish and striation of the sides has often been effected, the striation corresponding with the direction of the movement—evidence of importance when that direction may not be clearly seen by the bedding or other mode of occurrence of the rocks fractured." Then, in a note, "When," &c., "these polished and striated surfaces are commonly called '*slickensides*.'"

Before we can proceed to make use of this phenomenon for the purposes here indicated, a more critical examination of it will be necessary than it seems to have hitherto generally received. We must make sure that we are not confounding together appearances, which, in spite of their strong resemblance, may be due to very different causes. We now return to our proper subject.

We have, as we have seen, good authority for applying the term slickensides to some of the striated granite surfaces in this neighbourhood. A far more competent judge than myself declared his belief, after an inspection of one of the specimens now exhibited (but without having seen it *in situ*), that its appearance was caused by movement. Whether this supposition be correct or not, of this I am sure, that it is a most reasonable one,—

Πέτρη γὰρ λίς ἐστι, (περι)ξεστῇ εἰκυῖα.

But some of these specimens present faces which are most decidedly not to be called slickensides: they are striated, but not smooth, and moreover their striations, as is evident, have not been caused by movement, but are the result of structure or crystallization. Now, if we can sufficiently connect the two classes together, as I think we can, it will follow that as some have not, so none have been produced by movement; and therefore, if the example, which with such good reason might be ascribed to movement, be thus not attributable thereto, it follows that the greatest caution is necessary in looking for evidence of movement in slickenside surfaces.

The striated granite faces of which we now speak may be seen over a considerable area. I have observed them from Dalkey and Salt-hill to Glencullen and Kilmashogue mountain, forming a district, say six miles long by three broad. They are very common over the district in

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of the consistence of stiff clay. There is a most striking specimen of this in the Museum of the Society. It would probably be exhibited sometimes between the surfaces of beds which have been violently contorted while still in a slightly soft condition.

places where the rock is much exposed by quarrying; they are rare on natural exposures of rock, owing to atmospheric disintegration. Those which would be termed slickensides have generally a coating, which most generally consists of black, blackish, or grey quartz, and sometimes of white quartz, with occasionally, I think, feldspar mixed with it. The blackness seems to be owing to schorl permeating (as it often does) the quartz, and sometimes penetrating it in streaks parallel to the striations. Schorl is also often present on the surface, in capillary crystals, parallel to the striations, and sometimes it seems to have been present, and to have disappeared,* leaving a pseudomorphic striation on the quartz. Sometimes the striations consist entirely of capillary crystals of schorl, arranged with the most perfect parallelism on the granite face.† Mica is rare in and on the slickenside coatings; there is, however, a beautiful example of a striated face thickly covered with white mica. Some of these surfaces have a slight greenish colour, as if from chlorite, and some have a thin coating of what is apparently steatite. Several cases occur of surfaces carrying two sets of striations, one crossing over the other, both being quite distinct when that which is underneath is not too much concealed from view by the upper one.

The striations are usually very straight and parallel, and this often over many yards of length and width (in one case, in the Dalkey quarries, 32 yards by 19); and this gives to many surfaces, at first sight, exactly the appearance which we might suppose would be caused by the sliding and grinding of a huge mass of rock,

"Which moveth altogether, if it move at all."

Some of these surfaces have compelled me for the moment to believe that they had been striated by enormous friction. A person who had formed this idea might very easily pass by without closer examination, because he would know that groovings and scratches, caused by the scraping of coarse rocks on each other, would not yield any additional information as to their nature on a more minute inspection. But in the case of these surfaces, the appearance, which is sometimes so fallacious on a wide, general view, exhibits its true character when closely looked into. The striations are often very fine and delicate, and are plainly due to the crystallization or structure of the coating of the surface. Some of the faces, which might not be called slickensides, and have no smoothness, exhibit striations, which on the scale of a small specimen

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* Delabeche notices the "fugitive" character of schorl as sometimes exhibited in Cornwall. N. B.—Although he gives such an accurate account of the joints in the granite of Cornwall, and of the behaviour of the schorl, he never mentions any slickensides. Are we to conclude thence that they do not occur in that district?

† More massive crystals of schorl may often be found; but I have *never* seen them arranged thus; they are either beautifully radiating from many different centres, or quite irregular.

are very rude and obscure, but on the large scale are very distinct and observable. These, evidently, are of the same origin.

We have seen that these granite striated surfaces vary a good deal in character; we might say that they are of different species; but I believe I am correct in stating that the most movement-like of them can be connected by an intermediate series of insensibly gradating examples with others which have had most clearly nothing to do with movement. The slickenside hunter finds himself in the same difficulty as some other naturalists—he cannot define a species. The conviction grows upon one, after the examination of a large number of these surfaces, until it becomes irresistible, that the most movement-like and the most unmovement-like of them are exhibitions greatly varied and modified of the same action, that of crystallization.*

But a strong corroboration of this view is to be found, I think, in the mode of occurrence of these surfaces. The great bulk of them, of whatever species, are found on joints which are entitled to be pronounced of the same set at each place, and main joints. These have a dip of about 30° on the average, which becomes, generally speaking, steeper towards the S. W. of the district. Sometimes these joints are quite like planes of stratification; but they are at liberty to vary somewhat as to direction of dip from the mean at each place. The mean direction of dip also varies from place to place, as shown in the accompanying map.† These joints will often cease, and then set in again. It might be said that, as the granite is so cut up by joints (four sets at least sometimes appearing at one spot), these need not necessarily have any more relationship over the district than an accidental nearness of direction. But probably the combination of the two features, nearness of direction, and their being pre-eminently slickenside-bearing joints, points to the conclusion that they have a true connexion with each other.

Moreover, the great majority of the striations, of whatever kind or species, have a very observable nearness of direction at each place. To illustrate this, I have given a plan showing the *individual* strikes and striations for a place near Barnacullia, on the north side of the Three-

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* We may here observe that the Bray Head slickensides, which occur between the bed divisions and joints of the rocks, are unmistakeably owing to the asbestiform structure of the coatings with pseudomorphism.

† See Plate VI., Fig. 1. The continuous line is the outline of the granite. The longer single strokes give the mean *strike* of the striated joints at each place; the shorter double strokes, the mean horizontal direction of the striations. The planes dip towards the striation strokes.

X. Places where the averages are not of much value, but where there is yet a predominating direction among the striations.

V. Places where there is much confusion.

O. Places with a good exposure of granite, but no slickensides.

N. B.—It should be remembered that, as the planes dip at only about 30°, for the most part, their variations are in reality *less than half* what they seem to be on the map, which can only give the variations of the *strikes*. This applies, of course, to the other map likewise.

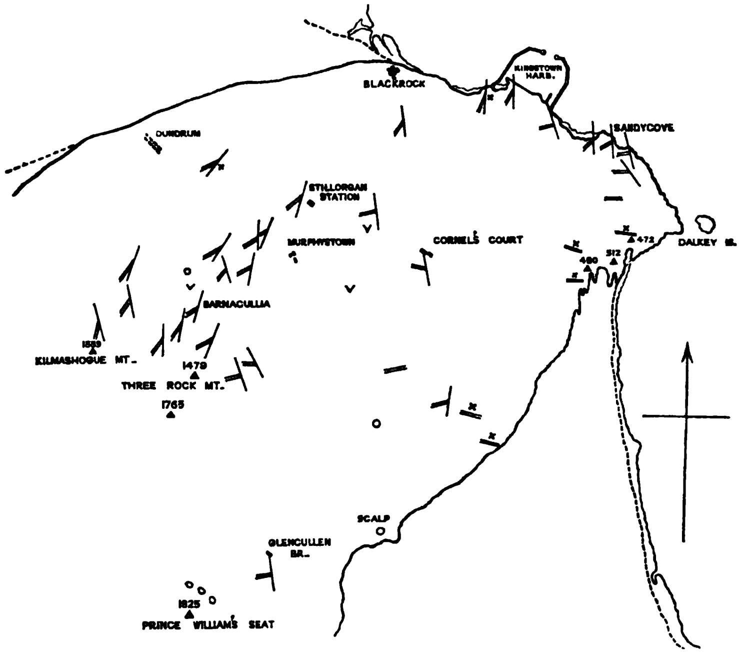

Fig. 1.—Map of the Directions of Striations on joint surfaces in Granite near Dublin.

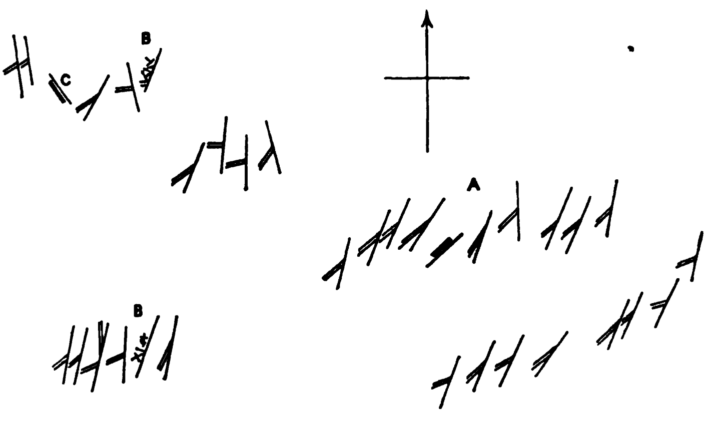

Fig. 2.—Strikes and Striations near Barnacullia.

TO ILLUSTRATE MR. CLOSE'S PAPER ON SLICKENSIDES.

Rock Mountain.* It is interesting to observe at *A* the persistence of the horizontal directions of the striations, while the planes vary. It seems, as may be observed elsewhere, as if the horizontal component was the essential part of the actual directions of the striations.

Oné may easily be tempted to overstate things in matters of this kind; this I am most anxious to avoid; but the facts as now stated are very decided. At places such as Sandycove, Murphystown, or Barnacullia, which afford a good number of these surfaces, a strange eye, if attracted to the slickensides, would in a very short time perceive the arrangement of them. And in places which, like the long line of quarries on the side of Prince William's Seat, present no joints which from their position seem to be promising, it is exceedingly improbable beforehand that we shall find slickensides.

On examining the map, Plate VI., Fig. 1, we notice some interesting particulars. The general tendency of the variations, both of the planes and of the striations over the district, follows a simple law. If a line be drawn from the top of the Three-Rock Mountain to the east pier of Kingstown Harbour, all the mean dips to the east of it will be found to run more southwards than those on the west of the line. So with the striations, the mean directions on the east of the line run more nearly east and west than those on the west, which turn towards S. W. and N. E. In passing then from east to west, the planes turn in one direction, in azimuth; the striations, in the other. It will be remarked also that, so far as our observations go, the proximity of the surrounding metamorphic Silurian rocks seems to be detrimental to the orderly development of the slickensides; either they are absent at the boundary of the granite, or, if present (as on Roche's Hill, in actual contact with the mica slate), the striations are less well developed, less normal in their directions, and more freely exhibited on irregular and abnormal planes.

The general law of the planes and striations is, then, very apparent. There are, however, unsatisfactory places, all of which are marked as such on the map; but the most of these have, as we have just seen, a perverse law of their own. And, moreover, among the places whose plane-directions are given in the map, several quite abnormal striated planes have been noticed, but only 19 out of 280: these have been omitted in calculating the averages, because it was impossible to say what influence should be assigned to them, if any at all.

The general arrangement of the slickensides is an interesting matter in itself; but, besides, it points to the conclusion, that since the different kinds of striations equally conform to the same general law, they

* See Plate VI., Fig. 2. In this map the longer single strokes give the strikes of the *individual* planes, which dip towards the shorter double strokes, which are the striations. The directions are accurate, the positions only guessed at. The distance between the two extremes is about a quarter of a mile. *Every* striated plane that was noticed at this place is here set down. *BB* are not striated, but bear irregular crystals of schorl. *C* is vertical.

are connected by a common relationship. Their directions have been determined by one and the same cause.*

We see in the phenomenon in question, leaving out the just mentioned exceptional cases, an illustration of what has been sometimes noticed elsewhere, "the uniformity in position of crystallizations over wide areas." Usually, when narrow fissures are filled with crystallization, the direction of the structure is transverse to the plane of the fissure; but here it is in that plane, and not only so, but determined towards a certain direction therein. We must seek the directing cause, then, in a polar force and that a somewhat widely acting one. The striations and the planes which carry them can vary independently of each other; there is, then, probably no connexion between the forces which have arranged each of them. The following consideration may be not without significance relative to the nature of the force we are in search of:—

The striated coatings are later than the joints which carry them; they were formed after the consolidation of the granite, but also they were formed before certain other joints which cut through them, or before the granite had attained its final structural condition; that is to say, after the cooling of the granite had begun, and before it was completed. Perhaps then we may have in thermo-electric currents the polarizing force we seek. We know that light is able to influence crystallization, as also the action of a powerful magnet. It seems easier to explain by thermo-electric agency, than by the more widely acting currents of terrestrial magnetism, the variations in direction of the striations which we have noticed, and also the fact that near the boundary of the granite (where the cooling of the intruded mass must have been comparatively rapid and irregular), the slickenside phenomena are either absent or confused. The magnetic currents might, however, affect in some degree the thermo-electric ones, and therefore the general tendency of the directions of the crystallization. Doubtless those patches of country which present no joints related to the slickenside ones were

* De Saussure, in "Voyages dans les Alpes," describes very carefully the now famous *Roc poli*, near the Hospice of St. Bernard. His description of it would be singularly well satisfied by some of the striated surfaces at Murphystown, taken together. It has evidently a slickenside coating, composed, as De Saussure says, of quartz and some dark mineral, which colours the quartz in places, and produces the black part of the glaze. De Saussure's first impression was that the phenomenon was caused by the movement of earth over the rock; but, as he thought the striations resembled those of a crystal of quartz, he was led to attribute the appearance to crystallization. Agassiz, but without having seen the rock, suggests glaciation, and Charpentier, friction between the parts of the rock, as the cause of its peculiar character. De Leonhard approves of this last explanation, but adds a very considerable modification, viz., that the heat excited by violent friction might fuse the surfaces, and so produce the glaze observed. In such a case we may and must choose for ourselves, and, comparing the accurate description of *Roc poli* with our remembrance of the Murphystown surfaces, venture respectfully on the opinion that De Saussure's second explanation is the true one, though perhaps he should have compared the markings to the longitudinal structure of fibrous quartz, rather than to the *transverse* striæ of a quartz crystal.

divided by some at least of their present joints when the striated coattings were deposited elsewhere; but the positions of those joints were not favourable to the passage or the effective action of the presumed currents.

It would be interesting to know if any law may be detected in the arrangement of the galena slickenside surfaces, or striations, or both. If such should prove to be the case, it might throw further light on the question of their origin.

X.—On the Remains of the Reindeer which have been found Fossil in Ireland. By A. Carte, M. D., F. L. S.

[Read May 13, 1863.]

It may be in the recollection of some of the members of this Society, that on a former occasion, last session, I had the pleasure of bringing under their notice the skull and antlers, in a very fine and perfect state of preservation, of a Reindeer, *Tarandus rangifer*, which were discovered at the end of July, 1861, on the verge of the Curragh bog, in the parish of Ballymadun, barony of Balrothery West, near Ashbourne, county of Dublin, about thirteen miles north-west of this city.

Since that time I have been so fortunate as to have obtained other specimens from different localities; and although these are not at all in so perfect a state of preservation as those already recorded, being but detached and mutilated antlers, nevertheless it may be desirable to place on record the localities from whence they were obtained, and with this object in view they are now submitted to the Society. Prior, however, to calling your attention to the specimens, I may be permitted to say a few words upon the geographical distribution of the existing species, as it is upon this that much, if not all, the interest which attaches to the specimens depends.

According to Sir J. Richardson, the Reindeer, *Cervus tarandus*, Linn., called by the Canadians, *Caribou*, from a corruption of the term *carré bœuf*, applied to them by the original French settlers in Canada, inhabits the northern regions of the earth, extending from Labrador through Greenland and Spitzbergen to the north of Europe, and Siberia to Behring's Straits; according to Pennant, it did not exist, in his time, in Iceland, or in the chain of islands between Russian America and Kamschatka. It has been introduced into the first named of these islands since 1770, and is now abundant there. Its range in Europe, according to Cuvier, however, never extends south of the Baltic.

A question has arisen as to the specific unity of the Reindeer, some authors holding that there are different species; while others, on the contrary, say that these so-called species are mere varieties. Dr. King, who accompanied Captain Back, is of the former opinion, assigning, among other reasons, the anatomical fact, "that the barren-ground species is peculiar, not only in the form of its liver, but in not possess-

ing a receptacle for bile,"—in this respect differing, according to this author, from the Woodland Reindeer, *C. tarandus* var. Sylvestris of Sir J. Richardson.

I must not, however, omit to mention that the same fact was stated, so long ago as the year 1674, by John Scheffer, of Upsala, Sweden, in his "History of Lapland:" Oxford, 1674. In his description of the European Reindeer he says:—"Likewise, instead of a bladder for their gall, they have a black passage in the liver."

This would seem to show that the gall bladder is absent in the Arctic Reindeer of both continents.

Dr. Gray, however, who is justly considered to be one of the best living authorities, in his Catalogue of the British Museum, classes them all as varieties of the one species—*Tarandus rangifer*—his varieties being the following five:—

1. The Woodland, *Cervus tarandus sylvestris*—Richardson.
2. The Great Caribou of the Rocky Mountains.—H. Smith.
3. Labrador or Polar Caribou.—H. Smith.
4. Siberian Reindeer (ridden by the Tungusians).
5. Newfoundland Caribou.

Sir John Richardson, in his work entitled, "Fauna Borealis Americana," treats of two of these varieties as well-marked and permanent. The first he calls *Cervus tarandus*, var. *Arctica*, "The Barren Ground Caribou." It is thus called because of its being restricted to the sterile tract of country that forms the most northern part of Canada, stretching north to the Arctic Ocean. This variety is of small stature, weighing from about 90 to 130 lbs.; but their horns, especially those of the old males, are large and much palmated. In this latter respect, there is much variation. However, Sir J. Richardson states that the majority of the adult males have a *brow antler*, in the form of a broad vertical plate, running down between the eyes, and hanging over the nose. In some this plate springs from the right, in others from the left, horn; in many there is a plate from each side, and specimens in which this plate is entirely wanting, are not uncommon. The plate is generally widest at its free extremity, and is set with four or five points, which are sometimes recurved.

Hearne observes that the Barren Ground Caribou has horns twice the size of those of the Woodland variety, notwithstanding that the latter are much larger animals.

The Barren Ground variety migrates to the coast of the Arctic Sea in summer, returning in winter to the woods lying between the sixty-third and sixty-sixth degree of N. latitude. The second variety Sir J. Richardson designates as *C. tarandus*, var. *Sylvestris*, the Woodland Caribou. It is much larger than the Barren Ground variety, attaining, according to Sir J. Franklin, a weight of from 200 to 240 lbs. Its horns are much smaller than those of the Barren Ground variety, and it is much inferior to it as an article of food. The proper country of this variety is a strip of low primitive rocks, well clothed with wood, about

100 miles wide, and extending at a distance of from 80 to 100 miles from the shores of Hudson's Bay, from the shores of the Athabasca Lake to those of Lake Superior.

Contrary to the habits of its more northern congener, this variety travels southward in the spring, crossing the Nelson and Severn Rivers in immense herds, in the month of May; passes the summer on the low marshy shores of James's Bay, and returns to the northward in September.

These two varieties appear to be peculiar to America; and it is remarkable that, while the latter is able to reach the isothermal of 60° to 65°, the former travels northward in summer, from about the latitude 65°, at which point the mean summer temperature on the shores of Hudson's Bay is about 40°, or similar to that of Dublin in winter. It is, therefore, very interesting to find that all the remains which have hitherto been found in Ireland correspond more closely to the characteristics of the Barren Ground variety than to those of the Woodland variety, the climatal conditions of whose existence seem to approach more nearly to those of the West of Europe during the present time.

The first naturalist who described the fossil remains of the Reindeer was M. Guettard (Dulac, " Melanges d'Histoire Naturelle," i. 19, et sq.), who considered certain fragments of antlers found in gravel at Etampes as belonging to that genus. Cuvier ("Oss. Foss.," 4th edit. tome vi., page 180), considered these, and others which were found in the cavern of Brengues, Dep. du Lot, to differ in some important particulars from the existing species. He did not, however, assert this positively, as at the conclusion of his notice of the fossils he expressed a hope that future researches would result in the discovery of more perfect specimens of the antlers and other portions of the skeletons, which would enable him to decide the question finally.

M. Schmerling found, in the caves near Liège, remains of the Reindeer, which he considered to be of a different species from the existing Reindeer, and in this view was followed by M. Dechristol.

Recently, M. Puel having obtained a great variety of specimens from the locality from whence Cuvier's specimens proceeded, made two communications to the French Academy of Science, abstracts of which are published in vols. vi. and xxi. of the " Comptes Rendus." The conclusion at which he has arrived is contained in the following extract:—

" This large number of specimens, among which we find a certain number quite decisive of the question; among which I may mention fragments of antlers, in a sufficiently perfect condition to exhibit the most characteristic peculiarities of the existing Reindeer, in the straightness of the parietal and the circular form of the mark left by the antler; have enabled M. Puel to satisfy himself, and to be able to demonstrate, that the fossil specimens are rigorously identical with those that are at present living in the Arctic regions.

" In order to give a rational explanation of the differences which are perceptible between the same parts in various specimens, he makes the

just observation, that sex, age, and individual circumstances exert a manifest influence on these variations."

Professor Owen, in his work on the British fossil remains, gives three instances of the occurrence of the remains of the Reindeer having been found in England, viz.: 1st, The skull and broken horns, found beneath a peat moss, in a small moor at East Bilney, near Dereham, in Norfolk, together with a mutilated antler; 2nd, Part of a cranium, found at Berry Head Cave, Devon, in a limestone cave, about seventy feet above the sea; and, thirdly, a metatarsal bone, found in the fens of Cambridgeshire, at a depth of about five feet beneath the surface; all these remains seem to have belonged to the common European variety.

Sir Charles Lyell, in his work on the Antiquity of Man, mentions the discovery of over 1000 antlers of the Reindeer in one cave in Glamorganshire; these have been identified by Dr. Falconer as belonging to the variety called *Cervus Guettardi*.

In Scotland, so far as I am aware, there is but one instance on record of the remains of the Reindeer having been found in that part of the United Kingdom. It is mentioned in the "Proceedings of the Royal Physical Society of Edinburgh," by Dr. Alexander Smith, 25th February, 1857, on the occasion of his exhibiting to that Society a fragment of a horn of a young female Reindeer, which was discovered in the basin of the Endric, near the hamlet of Croftamie, in the parish of Kilmaronock, Dumbartonshire, in digging a railway cutting, at about 100 to 103 feet above the sea level; the specimen was found mixed with shells, such as *Cyprina Islandica*, *Astarte elliptica*, *Astarte compressa*, *Fusus antiquus*, *Littorina littorea*, a proof that this locality was at one period beneath the sea, as all the shells are marine, and now existing in the adjoining inlet of the Clyde.

In Ireland, it would appear that in the year 1846, some remains of the Reindeer were found at Lough Gur, near Bruff, in the county of Limerick, and were recorded in the preface to the "Zoologist" for that year, by the editor of that periodical.

In the following year (1847) Mr. Oldham brought under the notice of this Society* the skull, horns, and lower jaw of a Reindeer, found by Mr. Moss at Ballybeta, near the Golden Ball, in the county of Dublin; these remains were mingled with those of some thirty individuals of the *Megaceros Hibernicus*. The above skull and horns are now before you, and you will perceive that they are almost identical with those which were found near Ashbourne, with the exception that the latter appear to have belonged to a much older animal.

I now come to the specimen which is the subject of this communication; it was found at a depth of about five feet from the surface, covered with turf and clay, and lay on marl and blue clay. There were some other bones found associated with the skull and antlers—such as

* "Journal," vol. iii., p. 252.

HEAD AND ANTLERS OF REINDEER FOUND AT ASHBOURNE.

To illustrate Dr. Carte's Paper on Fossil Reindeer.—(p. 107.)

ribs, &c.; but unfortunately Mr. Russell, on whose ground it was discovered, did not preserve them, and consequently their identity has not been ascertained. It will be seen from the illustration (Plate VII.) that the specimen is in a remarkably perfect condition, and also that the brow snag on the left antler is represented on the right antler by a simple spike.

The next specimens I would beg your attention to are three separate antlers; one a right antler, with a small portion of the skull attached to its base; the other two appear to be shed, and one of them to have belonged either to a female or to a very young individual. These three were found at a place called Coonagh, about three miles from Limerick, at the north side of the Shannon, and consequently in the county of Clare.

I am indebted to Mr. Brenan, of Dungarvan, in the county of Waterford, for sketches of two other very fine and perfect antlers, the property of Mr. Quinlan. It will be remembered, that Mr. Brenan is the gentleman to whom Irish geology is indebted for the investigation of the cave in which the bones of the Mammoth and other animals were found, March, 1859. Among these there were some fragments of Reindeer's bones.*

The antlers from which the sketches were taken were found, in the year 1741, in the bog of Ballyguiry, near Dungarvan, by Major Quarry, and have been in the possession of that gentleman's family ever since; and now, after the lapse of upwards of one hundred and twenty years, I am enabled to record them, owing to the kind exertions of Mr. Brenan.

To those already enumerated may be added one other specimen from the county of Meath, consisting of one antler of very diminutive size, from which it would appear to have been either that of a very young animal or of a female.

On comparing the dentition of the fossil specimen discovered at Ashbourne with the description of the dentition as given by Nordmann, in his "Palæontologie Russland's," of the existing Reindeer of Europe, I find it agrees in all respects.

XI.—On the Fossils of the Yellow Sandstone of Mountcharles, Co. Donegal. By Robert H. Scott, M. A.

[Read June 10, 1863.]

It may be in the recollection of some of the members of the Society, that, in the year 1856, Mr. John Russell, C. E., and I brought forward an account of a district in the south of Donegal, containing Carboniferous strata, which had been the subject of examination by us, when engaged

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* "Journal of the Royal Dublin Society," vol. ii., p. 351.

on our geological section for the engineering diploma. The paper in question was printed in the "Journal" of the Society, vol. vii., p. 181.

The district is that from which several specimens of fossil plants from Darney have been recently submitted to the Society by Professor Haughton, and have been figured in vol. ix. of our "Journal." It belongs to the lower part of the Carboniferous system, and consists of sandstones and arenaceous limestone. There are also in one or two places isolated portions of a sandstone which lies above the arenaceous limestone. This limestone contains a great number of fossils, among which are several plants, most of them very indistinct. However, within the last few days I have received from Mr. Harte a very perfect specimen of a fossil plant, somewhat resembling *Lepidodendron*, but differing from it in the large size of the scars in proportion to the diameter of the stem. This specimen was obtained at Inver, immediately below the town of Mountcharles, and appears to be somewhat similar to some plants obtained some years ago by Mr. Byron, in the county of Mayo, in the same locality as that from which the exogenous wood described by Professor Haughton at the last meeting was obtained. The sandstone on which this town is built is the largest of the isolated patches above alluded to. It had not been specially examined by us in 1856; but in 1861 Professor Haughton and I observed several bivalve shells, among others *Cucullæa Griffithii*, in a heap of stones on the roadside. This fact, and the knowledge that plants were abundant in the sandstone, induced me to pay a fresh visit to the locality, in July, 1862. I was then accompanied by Mr. Dickinson, who selected the district for his geological survey, and determined the boundary of the sandstone with considerable care. It is very limited in extent, never reaching the sea level, nor extending further inland than the Eanymore River. It is penetrated in the middle of the street of the town by a trap dyke. From the similarity of its plant remains to those of Darney, &c., it appears that this bed belongs to the yellow sandstone group, forming the upper member of it, as it lies distinctly under the lower limestone, which does not appear before we reach Ballintra, on the Ballyshannon road. When I was just leaving the country, I went into a quarry which had been recently opened, close to the mill at Mountcharles, and found a large number of well-known carboniferous mollusca, such as *Orthis crenistria*, *Euomphalus calyx*, &c., associated with the plants, and with other markings of organic origin. The presence of these molluscan remains proves beyond a doubt that this sandstone, and that at Darney also, belong to the carboniferous epoch, and not to the old red sandstone. Associated with these and the plants I noticed several isolated markings, which appeared to be more regular in shape than the fragments of vegetable remains usually are, and to bear some resemblance to fish scales. I did not bring any of these away, but I asked Mr. Harte, if he was working at the quarry, to keep a look-out for anything of the kind which he might see. This he most kindly undertook to do, and his search has resulted in the discovery of some fossils which appear to be the remains of fish. But, whatever the opinion of the Society may be as to these specimens, there can be no

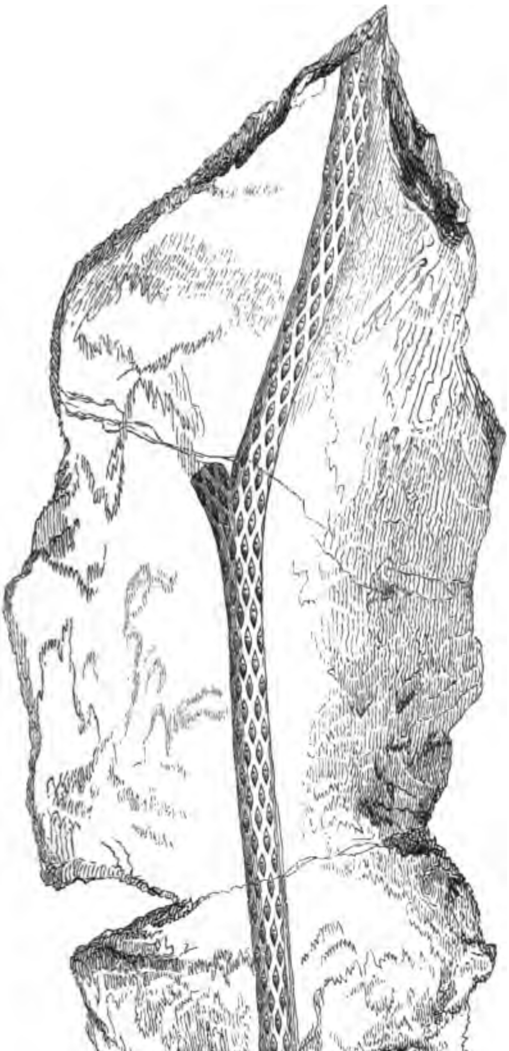

Fig. 1.

Fig. 2.

Fig. 3.

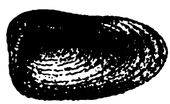

Fig. 4.

Fig. 5.

TO ILLUSTRATE MR. SCOTT'S PAPER ON THE FOSSILS OF THE YELLOW SANDSTONE OF MOUNTCHARLES, CO. DONEGAL.—(p. 109.)

doubt as to the character of one fossil which I have obtained, which is a portion of a palatal tooth of a species of *Psammodus*, probably *P. porosus*.

I have represented (Plate VIII., Figs. 1 and 2) the plant stem, which my friend Mr. Baily is disposed to consider to be nearly allied to *Sagenaria Weltheimiana*. Fig. 1 is the whole specimen, reduced to one third natural size; Fig. 2 gives a portion of the stem, natural size; Fig. 3, a portion of *Cucullæa Griffithii* (Salter), probably a variety of *Cucullæa trapezium;* Fig. 4, *Avicula Damnoniensis;* Fig. 5, *Orthis* (*streptorhynchus*) *crenistria*. These three shells were found in great abundance in the quarries under the town of Mountcharles.

XII.—The Eskers of the Central Plain of Ireland. By G. Henry Kinahan, Geological Survey of Ireland.

[Read November 11, 1863.]

On examining the contour map of Ireland, a reduced copy of which will be found in Sir R. Kane's "Industrial Resources of Ireland," it will be seen that, when Ireland was 500 feet lower than at present, what is now the central plain of Ireland was then a sea, in which towards the east there were a few high islands. This sea was open on the east from Dublin to Dundalk, while on the N., W. and S., it was bounded by numerous islands, between which were channels and straits, the widest of the latter running out where Galway Bay is now situated.

The tide and other currents flowing among these islands, and in and out of the channels, must necessarily have formed numerous shoals, bars, and sandbanks, which seem to be represented by the Eskers of the present day. One of the chief currents seems to have flowed from the N. E. towards the S. W. on each side of the high land now called Slieve Aughta, and from thence out through the present mouth of the Shannon. On looking at the contour map, we shall see that there is a low valley, which may have been formed by this current. This valley enters Ireland towards the N. E., on the north of Lough Neagh, and from thence runs by that lough, Cavan, Loughs Ree and Derg, to the mouth of the Shannon. That a current did flow in this direction seems proved by the long narrow ridges of drift, miles in length, that occur on the S. W. of Gort, and on the W. of Scariff; all of which are blunt towards the N. E., while they taper to the S. W., except on the S. W. extremity of Slieve Aughta, where the two currents met, and counteracted one another, and formed the drift mounds into round dome-shaped hills. Another current seems to have run along the east edge of the Burren, and has left most of the country in the neighbourhood of Galway, Gort, and Ennis a bare rock, the drift only occurring in long patches, or where there was some impediment which broke or diverted the current, and protected the drift.

This may have entered the present plain to the N. W. of Killala Bay, on the west of the town of Sligo, and formed the low valley that lies along by Loughs Conn, Mask, and Corrib, and the towns of Galway and Ennis. What seems to be an additional proof that a current ran in a south direction from Galway to the mouth of the Fergus is, that in all the drift on the south side of the Shannon, from Foynes to Tarbert, there are numerous boulders and fragments of the Galway granites, traps, and altered rocks.

There are three forms or classes of Eskers, which we will call *Fringe Eskers, Barrier Eskers,* and *Shoal Eskers.*

The *Fringe Eskers* occur fringing high ground.

The *Barrier Eskers* stretch from one high ground to another, or run out as a spit or bar from high ground.

The *Shoal Eskers* have been so called as they seem to be similar to the shoals and shifting banks of the present day. They have no regular form, sometimes being low undulating hills, but generally occurring in short ridges, that run every way, often at nearly right angles to one another.

The best examples of the *Fringe Eskers* will be found near the high land that bounds the plain. A good example occurs to the south, in the Queen's County, running from Stradbally to Timahoe, fringing the high land there situated.

For good examples of the *Barrier Eskers* we must look in the straits and channels, each of which has its bar or barrier. Mr. Jukes, in his "Manual," has described one in the valley of the Barrow; and, as an example, we shall refer to the Maryborough Esker, which begins on the flanks of Cullenagh, and runs past Maryborough to near the Slieve Bloom Mountains. The regular *Shoal Eskers* occur in the plain, a good example being the Curragh of Kildare, which is formed of flat, undulating, gravelly hills. An example of Shoal Esker, in which the ridges are well marked, short, and run in every direction, occurs about seven miles south of Ballinasloe, all about the village of Kiltormer.

All these Eskers are modified by local circumstances—the Fringe often becoming Shoal Eskers for a time, when there is a break in the high ground; and in the large Barrier Eskers, in a long stretch from one mountain to another, there will be various inequalities in the ground, all of which will modify the Esker. As an example, we shall refer to the large *Barrier Esker* that stretches from the northern part of Slieve Aughta to Slieve Bloom. One of the branches of this Esker begins about three miles S. E. of Loughrea, forming a fringe on the south of the high land that lies between Masonbrook and the village of Tynagh. But this is also modified, as about half way between these places, immediately east of the hamlet called Leitrim, there is a break in the high ground, and consequently the Esker is affected, and changed into a shoal. At and about Tynagh, the *Barrier Esker* has changed into a shoal; but about a mile east of the village it becomes well defined, and strikes off to the E. S. E.

If this *Barrier Esker* were followed, other modifications would be met

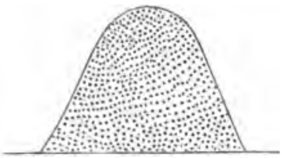

Fig. 1.

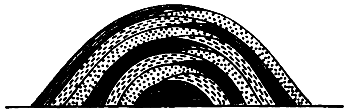

Fig. 2.

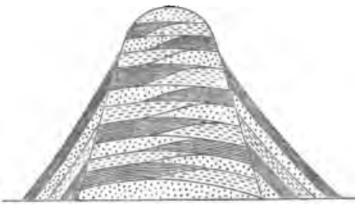

Fig. 3.

Fig. 4.

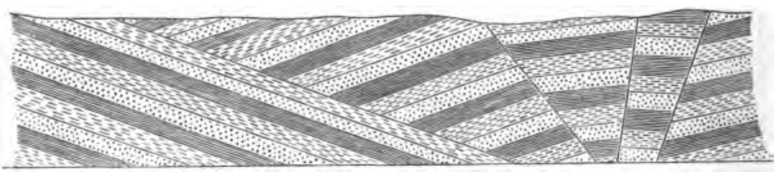

Fig. 5.

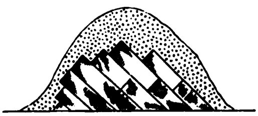

Fig. 6.

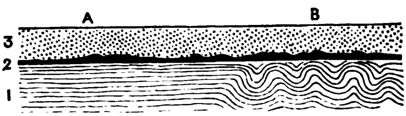

Fig. 9.

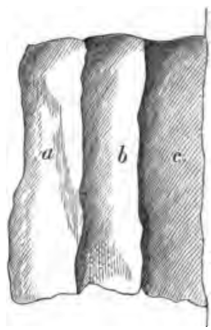

Fig. 7.

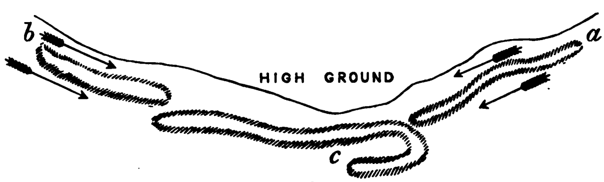

Fig. 8.

[Scale, 20 feet = 1 inch.]

TO ILLUSTRATE MR. G. H. KINAHAN'S PAPER ON ESKERS.

with; but we have traced it far enough for our purpose, as at Tynagh the *Barrier Esker* changes into a *Shoal*, while on the west of Tynagh it had been modified by local circumstances into a *Fringe*, which latter was also in one place modified, having been changed into a *Shoal* at Leitrim. In the same way, in a large system of Shoal Eskers we shall find small Barrier and Fringe Eskers, according to the lie of the country.

All the Esker drift seems to be a modification of the ordinary drift, the former being the latter well washed and sifted. When the drift was first deposited, it was, comparatively speaking flat—hills and mounds only occurring where there were crags and reefs of rock. Afterwards, as the land rose, this deposition came more under the influence of the currents than previously, which carried it hither and thither, entirely removed some of it, washed the clay out of part of it, and formed the banks and ridges.

To find the gravel in an Esker stratified is not unusual, but it often occurs unstratified, as represented in Plate IX., Fig. 1.* Some of these ridges or Eskers may have been formed by two currents that acted alternately in different directions, like the ebb and flow of our present tides, which formed a cross section, like what is represented in Fig. 2. These were often modified, probably by currents that set at right angles to those first mentioned, which cut off part of the former depositions, as represented in the centre of Fig. 3. In places there may have been a third set of currents, which banked up new beds against the ridge, as shown in Fig. 3, or there may have been modifications in these cases—only one side of the centre deposition may have been carried away, or on one side of the ridge the new beds may only have been banked up. Other Eskers are stratified on one side only, as in Fig. 4, as if one current was much stronger than the other, or as if there was still water at the back of the bank, and the fragments, driven up the slope, had rolled over into the still water on the other side.

Some of the Eskers are likely to have been found in the centre of a current, when a reef or other impediment formed a cutwater, below which a long ridge was formed. This gave a section of the Esker like Fig. 6, which is taken in a cut across an Esker a little south of Pallas, and eleven miles S. E. of Loughrea.

In all the stratified ridges, shifts or faults (which are represented at the right-hand side of Fig. 5) are of frequent occurrence. These, though they puzzle some people, are easily accounted for, as the same phenomenon appears in all kinds of drift, and can be examined going on at the present day in various places. It can be well seen on the south slopes of the Arra Mountains, a few miles east of Killaloe, where there is a drift

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* A similar section to Fig. 1 can be seen in the Esker that runs from Gortymadden to Killimor, county of Galway; to Fig. 2 in the Esker that runs through Stradbally demesne, Queen's County; to Fig. 3, on the road from Stradbally to Timahoe, about a mile from the latter place; and to Fig. 4, where the road crosses the Esker N. W. of Timahoe. Fig. 5 is similar to the section that formerly was seen of the Esker at Maryborough.

from 40 to 200 feet deep, formed of layers of fine sand and clay. Through this the mountain torrents flow, cutting deep gorges. As long as it is only the clayey drift they are cutting, the sides stand; but when they come to a bed of sand, it immediately begins to run, and after a while, when the banks are undermined, the whole sinks bodily. Acres here have sunk in places as much as fifty feet. These slips have generally an uneven surface, like rude steps of stairs (*a, b, c,* in Fig. 7), there being various cracks, down which the mass slid, as if, when it first gave way, the outer part reached a firm bottom first, and confined the running sand from further egress. In the same way the faults occur in the Eskers; when the sides are cut away to a fine sand, it runs, and the mass over it slides down, and forms the faults. These are of frequent occurrence in gravelly drift, as a section of any length is rarely seen in which one of them does not occur. Mr. A. B. Wynne figures an example in the Explanation Sheet 126, p. 22; and Mr. John Kelly has figured another, in a paper read some time since before your Society.*

Many of the *Fringe Eskers* may have been formed by a current which alternately set from opposite directions round high ground (from *a* to *c*, and from *b* to *c*, in Fig. 8). These Eskers would give cross sections like Figs. 2 and 3, and a longitudinal section like Fig. 5, or a modification of it; but in most places it would not be nearly so regular, as all the modifications previously mentioned are likely to occur.

The *Barrier Eskers* seem probably to have been formed where two currents met. If the currents were of equal magnitude, they would form sections like Fig. 2, or a modification of it; while if one was much stronger than the other, the cross section would be like Fig. 4. They may also have been formed by an island which split a current, and formed a spit or bar from it.

Many of the *Shoal Eskers* may have been formed by the detritus carried in icebergs. Icebergs at the present day are inclined to drift to particular localities, and there melt; therefore we may presume that the same laws governed them in former ages. In these places, as the ice melted, the contained rocks and clay were carried with the current, forming a ridge when the current set one way, or a dome when there was an eddying current. This would fully account for our finding in some Eskers water-worn and angular fragments mixed up together, the angular fragments being dropped from the ice, and the water-worn fragments mixed with them from the currents; it would also account for so many of the mounds being together. That some of the fragments were not under the action of water is evident, as their angles are quite sharp, and some of them are of such frail materials (soft shale), that were they under the action of water, even for a day, they would have been ground to powder. Other blocks, some of them tons in weight, have been carried miles from their parent rocks, and are now perched on the sides of these ridges.

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* "Journal of the Geological Society," vol. vi., p. 133.

XIII.—On Crumpled Lamination in Shales. By G. H. Kinahan, Geological Survey of Ireland.

[Read November 11, 1863.]

In shales the lamination is generally considered *to be parallel to the planes of stratification.* That it is not always so has often occurred to me, and now I draw attention to it as it also occurs in recent deposits.

The first place I remarked crumpled lamination was in the cleaved shales or slates on the sea coast of Clear Island, county of Cork, where the top and bottom of the bed were quite regular, while the lamination or *ribbon* (as it is called in the slate quarries) was crumpled. I afterwards remarked the same thing in Benduff slate quarry, near Rosscarbery, where the grits on the north and south are quite steady, dipping at a high angle to the north, while the *ribbon* is wavy. But, as the character of the country in these places shows much twisting and contortion, I did not much mind the crumpled lamination, but put it down as unimportant.

Since then I remarked the same thing in shales of the Queen's County coal-field, in nearly undisturbed rock, in some of the slate quarries near Broadford, county of Clare, and in other places.

Lately, while examining the country, north of the village of Killimor, county of Galway, I had occasion to walk up a new cut through an alluvial flat which exposed the following section:—

		Feet.	Inches.
3. Alluvium, from 2 feet to		3	0
2. Peat, from 3 inches to		1	0
1. Marl, ...	over	6	0
		10	0

The marl had been deposited in beautiful lamination. In some places the laminæ were parallel with the top of the bed, as represented at A (*vide* Plate IX., Fig. 9), while in others, as shown at B, they were crumpled.

The solution which I would offer is this :—Rocks when deposited first, though flat, are rarely horizontal, a slight fall always occurring to some side or another. The shales, after they were deposited, were in a semi-fluid condition, and capable of movement, and therefore slipped down the incline; more especially if one part dried faster than another, which would cause the dry portion to be disposed to slide down against the wet part, and crumple up the lamination. The surface of the bed would still remain flat for another set of rocks to be deposited on it, as the alluvium was in the section I have just mentioned.

XIV.—On the former Existence of the Polar Bear in Ireland, as is probably shown to be the fact by some Remains recently discovered at Lough Gur, County of Limerick. By Alexander Carte, M. D., &c.

[Read January 18, 1864.]

It would appear that the interest which has hitherto attached to the discovery and examination of palæontological remains, in the solution of geological problems, is being gradually transferred to mammalian remains, and even to those of man himself, and of the objects with which we may be enabled to connect him. As the consideration of such relics removes us rather from the interior to the surface of the earth, it may become a question, in future, whether the pursuits of the archæologist may not be commensurate with those of the geologist, if not identical.

It is not my province, nor is it my intention, to determine the exact *geological* value of osseous remains, in the communication which I have at present the honour to submit to the Society; but I may be permitted to observe, in anticipation, that, however important the results of palæontological research may be, the increasing attention which is being paid to the remains to which I have alluded will not be ineffectual in enlarging the scope of geological science, as well as in, probably, bringing into a more satisfactory adjustment many subjects which have of late been found to harmonize very badly with certain conclusions of the science of geology. These conclusions we may fairly consider as only provisional.

If we suppose that mammalian remains, and above all human remains, penetrate to a certain distance under the surface of the earth,—in a word, to a distance greater than that to which they have been hitherto traced,—the question will arise how far down we are to expect to find them. The solution of such a question will depend on the continual recurrence of such investigations as the present one, and in these the cause of truth will derive benefit from the joint exertions of the archæologist and the geologist.

The fact of the discovery of such remains, at comparatively slight depths, and not, like lower forms of life, in the lowest geological strata, awakens important considerations, as the ordinary rule, that forms of life arrive at their maximum developement by a gradual process, will hardly account for the abruptness of the appearance of these fossils, as compared with the gradual developement of other orders.

Familiar instances of this ordinary rule will occur to every one in the case of the fossils of the different subdivisions of the tertiary, and of the fossils common to the oolite and chalk; if, indeed, the same may not be said of the lower geological formations. We may therefore express some surprise that the palæozoic crustaceans, or at least the liassic fishes as well as saurians, should not in a single instance ever have been known to have been accompanied by any approach to the

higher orders of life, viewed as precursors to their predominance at or near the surface in the tertiary and post-pliocene formations.

I do not pretend to offer the foregoing reflections for more than they are worth, but they seem to me to arise naturally out of the subject of the communication which I propose at present to lay before you.

It may be well to premise a few words on the geological and topographical features of the district in which the specimens now before you were obtained.

The geological formations in the vicinity of Lough Gur consist of the Lower and Upper Limestone, the lake being immediately surrounded by nearly horizontal strata of the former; and the chain of detached trap rocks, to which the fertility of the celebrated Golden Vale, near Limerick, as well as the district under consideration, is owing, runs in a diagonal direction to the north-east of the lake from beyond Pallasgreen, as far north as Clarina, above Limerick, near the banks of the Shannon, for a distance of about twenty-five miles. Immediately to the north-west, north-east, and south-east of the lake, we find three isolated patches of these remarkable eruptions, which form a marked feature throughout the whole district—the Old Red and Yellow Sandstone being not far distant on the south and south-west towards Bruff and Ballingarry, at which latter place, about fourteen miles distant, we meet with another district of the trappean rocks just referred to. From this it will be seen that the limestone forms the most prominent feature of the district in which Lough Gur is situated.

In the present state of the inquiry, I am not prepared to offer an emphatic opinion as to the circumstances attending the deposition of the bones which have been obtained from the bed of this lake. I have made as minute inquiry respecting the locality as was possible; and from the information I have been kindly supplied with by my friend, Dr. Samuel Bennett, of Bruff; by my brother, Mr. Thomas Carte, of Limerick; and Mr. William Hinchy, the chief agent in procuring the bones, it would appear that the margin of the lake is studded with structures of antiquarian interest,—such as stone circles, ruins, and monuments of supposed Druidical era, as well as castles and fortresses of more modern date,—and is surrounded for the most part by comparatively elevated hills, varying from 300 to 500 feet in height, and composed of the limestone before mentioned.

Some attempts have at various times been made by proprietors to drain the lake, and in consequence its depth has been lessened from about sixteen to eight feet on an average, the drainage having been effected by an artificial cutting. There is also a natural outlet formed by a subterranean stream running under Knockfennell Hill, lying to the north of the lake, through which the water passes for about a quarter of a mile to the west towards Grange.

It is remarkable that Mr. Brenan describes such subterranean streams or rivers in connexion with the limestone caves of Dungarvan;*

* "Journal of the Royal Dublin Society," vol. ii., p. 344.

and, as if to complete the analogy, there is such a cave to the north of Lough Gur, near Knockfennell Hill, called Red Cellar Cave, as well as many others throughout the district extending from the celebrated caves of Mitchelstown, northward, exhibiting the cavernous structure of this limestone plain generally, as I am informed by Sir Richard Griffith. I may also mention, that as Lough Gur has no corresponding natural outlet to counterbalance the springs by which it is alone supplied, its connexion with the submerged remains may not be as intimate as might otherwise be supposed; and the following suggestions may perhaps explain the fact of the presence of the animal remains in it. There may have been a low-roofed limestone cavern, which was inhabited by the animals, and which has been obliterated by the solvent action of the water of subterranean streams, like those above described, which has eaten away its walls and roof, and formed a lake in its place. Several of the species, of which remains have been discovered in Lough Gur, are known as occurring elsewhere in cave deposits.

I may also observe, that accidental deposition can hardly be supposed in the present instance, if we consider the enormous accumulation of the bones already disinterred from the bed of the lake; but I am inclined to attach much probability to the speculation of my friend, Mr. Jukes, who has kindly permitted me to exhibit the detailed maps of the district, namely, that the Polar Bear, and other animals, would hardly have existed at any great distance beyond the range of their final resting place in the lake, especially as, according to his maps, it will be seen, from the deficiency of drift in the immediate vicinity of Lough Gur, that the alternative of such an agency cannot be referred to as a means of transport.

It would appear that these bones have been obtained by the country people in considerable quantities round the margin of Garret Island, which is situated in the centre of the lake, upwards of twenty tons having been, from time to time, already raised, and used for manure; and it would seem that they consisted of a very heterogeneous assemblage, such as (besides the bones, the subject of the present paper) antlers, bones and skulls of deer, pigs, horses, cows, dogs, goats, sheep, and, according to Richardson, reindeer; together with human remains and stone celts, and, as I have been informed by the Rev. Mr. Gabbett, of Charleville, ancient iron swords, and a canoe formed from the solid trunk of a tree.

In a lake surrounded with human structures, one of which still remains on Garret Island itself, we might expect to find, in fact, anything even comparatively modern; but the bones and ancient human relics can never for a moment be confounded with such irrelevant elements, and a satisfactory account of the circumstances attending their submergence will remain to test the ingenuity of the geologist or antiquarian. Mr. Long, who is at present engaged in translating a portion of the "Book of Lismore,"* informs me that mention has been made in

* THE FENIAN DEER HUNT OF LOCH GAIR—(*Book of Lismore, folio* 196).

"They proceeded eastward through Glen Fleisc, and south of Da-chich-ndanann (the mountain called the 'Two Paps of Danann'), and through the head (or end) of

that work of ancient royal hunts in the vicinity of Lough Gur, one of which is described as having taken place over the brow of the hill of Knockfennell, where an attendant, having been separated from the hunting party, was precipitated with two hounds, together with the quarry, a deer, into the waters of the lake.

Various theories might be offered as to the question of the submergence of these relics in the mud of Lough Gur; but it will hardly be within the limits that I have proposed for myself on the present occasion to enter further on this interesting question, as I shall feel that the end I have had in view will have been obtained, should the incomplete observations I have ventured to submit for your consideration be effectual in enlisting the co-operation in this inquiry of those whose pursuits, whether geological or archæological, render them competent to afford the solution of a problem which it will constitute my sole merit to have proposed.

It is well known that there are two distinct types of the Bear family found fossil in the British Islands; namely, the Great Cave Bear (*Ursus spelæus*), and the Fen, or Brown Fear (*U. arctos*). A third was at one time thought to exist, the *Ursus priscus;* but this, according to Professor Owen, is now regarded as merely the female or young of the latter species.

I hope to be able to demonstrate to you this evening that there is a third species; and, although I regret to say the segments upon which my identifications have been based are few, nevertheless they are so characteristic, that little room will be left for doubt with respect to their specific distinction, as compared with homologous portions of the *Ursus spelæus* or *U. arctos*, and of their closer affinity, if not identity, with the Polar species, or *Ursus maritimus.*

It should be borne in mind that, in comparing osseous remains one with another, the anatomist is expected to make all the allowances pos-

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Moin Mor; and the servant (or gilla) stopped after the rest to take a drink; and as he was coming after his people, a fierce wild Agh (a deer) started before him; and he had Cailte's two hounds, and one of them pulled away the chain, and followed the deer, and the servant, being grieved thereat, let go the other hound; and the deer went up by Ath Frenair, where Mac Con was being cured, and through the end of Magh Mi, and to Rosadh-na-Righ, and to Rosadh Ruadh, and through the wood of Ceann Fheabhrat, and through Firt Sceith, the place where Sciath Bhreac, son of Dathchaoin, was slain by the Clanna Morna, into Mairtine Mumhan (i. e. the territory of the Mairteneans of Munster), and into Cliu Mail, the son of Jugaine, and to Eachlascaibh Eachuladh, and to Loch Gair, which is called Loch-na-Machraidhe, and around the lake, and the four of them leaped into the lake.

"Cailte and his eight (companions) went southwards to Abhan Mor (i. e. the Blackwater), in the land of Fearmuighe (i. e. Fermoy).

"Cailte looked back, and not seeing his servant, they returned in search of him, and they came along the same path to Ath-na-Foraire; and they got the track of the deer, hounds, and servant to Loch-na-Machraidhe; and Cailte said, 'It is here our hounds and servant have been carried; and Fear Aoi, the son of Eoghamhal, that decoyed them, that is, the man of this Sighe above; and we have no power over the Tuatha De Danañs.' They passed that night sorrowfully in the rock of Loch Gair, until the dawn of day on the morrow, and then they proceeded eastward into Mairtine Mumhan," &c. &c.

sible in reference to age or sex, to account, as far as lies in his power, for observed differences, but such allowances must be kept within due bounds; and in the present instance due regard has been paid to this rule, but the differences still remaining are, notwithstanding, too great to admit of a more satisfactory explanation than that supplied by the supposition of specific distinction.

The segments consist principally of a right-arm bone, or humerus, unfortunately deficient as regards the head, which appears to have been eroded by the action of the water of the lake, and an entire left-thigh bone, or femur; there are also an entire right fibula, the two first segments of the cervical vertebræ (atlas and axis), anchylosed, and much mutilated, together with portions of three ribs.

On comparing the humerus from Lough Gur with that of a corresponding segment belonging to the Great Cave Bear (*Ursus spelæus*), it will be seen to differ from the latter in the following particulars:—The shaft or body of the bone is of a stronger or more robust formation, and the deltoid ridge is much more prominently marked, which causes the shaft of the bone to be more triquetrous or prismatic in shape, and also greatly increased in diameter in the antero-posterior direction; the deltoid ridge also extends further down on the shaft of the bone, and its distal termination is more prominent, scabrous, and rough; the antibrachial or condyloid extremity of the bone is likewise considerably wider and though the supinator ridge does not extend, comparatively speaking, so far up on the body of the humerus as in that of the *U. spelæus*, nevertheless the surface for the attachment of the muscles is much wider, and its free or external border is rough, forming a prominent angle at its upper part, rather than a gentle symmetrical curve, as is the case in that of the *U. spelæus*.

The internal tuberosity of the condyle is also thicker, rougher, and stronger, and extends considerably more inwards, where it terminates in a well-marked recurved spine; the surface occupied by this tuberosity has likewise a greater superficial extent than is presented by the similar process in the humerus of the Cave Bear.

In all these anatomical characters in which the Lough Gur specimen differs from that of the Spelæan Bear, it not only approaches, but seems identical with the same characteristic points of the humerus of the recent Polar species.

On comparing the femur obtained from Lough Gur with similar segments of the Spelæan Bear from the cave of Gailenreuth, I have also found a marked difference presented in the following particulars:—Although the Lough Gur specimen is a shade longer, nevertheless its shaft or body is slighter in circumference, presenting a greater convexity anteriorly; it is also much more cylindrical in shape than those of the Spelæan species, in which latter the shaft is much straighter, and considerably more flattened in the antero-posterior direction. The transverse diameter of the former, measured at the centre of the long axis of the bone, is $1\frac{5}{8}$ inch, while that of the latter, or *U. spelæus*, is $1\frac{7}{8}$ inch.

The trochanter minor in the Lough Gur specimen is, as it were,

thrown more on the posterior aspect of the bone, which appears to be caused by the greater width of its proximal end,—the consequence being that it exhibits a less marked projection on the internal aspect of the bone, as compared with the homologous part of the *U. spelæus*; and this difference becomes strikingly apparent when we place both femora in a similar position on a flat surface, and view each bone as it rests on its head and condyles anteriorly. There is also another essential difference, namely, that the trochanter major of the Spelæan Bear is much larger and rougher than that of the Lough Gur specimen, and the inter-trochanteric ridge, which is prominent and well marked in the former, is almost altogether absent in the latter, being in this last replaced by a longitudinal groove that separates the two trochanters; or, in other words, the inter-trochanteric ridge in the femur of the Spelæan Bear is continued from the great trochanter diagonally across the posterior aspect of the shaft of the bone to meet the lesser trochanter, defining in its course the inferior extent of the digital fossa; while in the Lough Gur specimen the boundary of the fossa above alluded to becomes obliterated in contiguity with the lesser trochanter, from the want of continuity in the inter-trochanteric ridge.

The last specimen—or, to speak more correctly, specimens—to which I shall call your attention, consists of the two first segments of the cervical vertebræ (atlas and axis), which are completely anchylosed together, the line of junction running in that of the articular surfaces of both bones. Unfortunately, both these vertebræ are much mutilated, especially the former, whose transverse processes are completely destroyed on both sides.

Owing to this, we lose one of the means of comparison, and consequently of distinction, between the various species. However, in the second (the axis), the extreme depth of the neurapophysis would incline one to conclude that the animal to which it had belonged was the *Ursus maritimus*.

From the foregoing determination of the specimens before us, I hope I have succeeded in establishing the fact of the occurrence of an additional species of the Bear family, not formerly known to have existed in Ireland; and if it be decided by competent authorities that the specimens are fossil, or even subfossil, I trust I shall not have laboured in vain; and should the Lough Gur specimens be considered as affording sufficient evidence of the existence of the Polar Bear in these latitudes, perhaps the ordinary specific name, in such instances as the present, might be qualified by the affix "*Subfossilis*."

I may conclude by saying, that I cannot sufficiently express the obligations I feel to the Earl of Enniskillen for the means so liberally placed at my disposal, which enabled me to carry out the identifications of these specimens, as I may safely say, that without the aid of his Lordship's beautiful specimens, obtained by him in person from the celebrated caves of Kühloch and Gailenreuth, in Franconia, which he has permitted me to lay before you at this meeting, I should have experienced much greater difficulty in arriving at a satisfactory conclusion with any degree of certainty.

XV.—Analysis of the Steatitic Mineral found at Ballycorus. By M. H. Ormsby, A. B.

[Read November 11, 1863.]

This mineral was found last March, when we were making a survey of the Dublin district. Below the shaft of the chimney of the lead works, near the old mine, there are several heaps of waste that were thrown there when they were working. In one of these there was a large granitic or feldspathic mass, which when struck with the hammer fell to pieces *outwards*, and revealed this green mineral running through the mass, having a sort of prismatic structure. I am sorry that I have not got any crystalline specimens to lay before the Society, as they were all broken in the carriage or lost since.

The specific gravity of the mineral is 2·738. It scratches gypsum slightly, and is deeply cut by calcite; so that its hardness is a little above 2°. It is unctuous to the touch, although the analysis gives but a very small percentage of magnesia; in the forceps before the blow-pipe it glows brightly, becomes white, and slightly fuses on the edge; it dissolves in borax, and leaves a siliceous skeleton; the bead is colourless when cold, but greenish when hot, showing the presence of iron; no manganese could be detected, even with the nitre test.

The analysis was made in the College Laboratory. It was begun by Mr. W. H. Wynne when I was away, and I finished it myself when I came home. It was made in the usual manner, and nothing remarkable occurred till the end, when we had got the chlorides of potassium and sodium together for separating. We digested spirit on them, filtered, evaporated the filtrate, and put a morsel of it, on platinum foil, into the flame of a Bunsen's lamp. The characteristic carmine flame of lithia immediately appeared. Although the weight in the analysis may appear but small, viz. 0·04 grs., yet the test was perfect, and there can be no doubt whatsoever that the mineral contains a trace of lithia.

The results of the analysis are as follow :—

	Percentage.	Atoms.			
SiO_3, ...	48·20	1·06	106	4·24	17
Al_2O_3, ...	33·92	0·65	67	2 44	10
Fe_2O_3, ...	1·88	0·02			
KO, ...	8·52	0·17			
NaO, ...	0·60	0 02			
CaO, ...	0·64	0·03	25	0·1	4
MgO, ...	0·68	0·03			
LiO, ...	0·04	—			
HO, ...	6·00	0·66	66	2·64	10
	100·48				

The empirical formula therefore is—

$$4RO + 10Q_2O_3 + 17SiO_3 + 10HO,$$

giving the rational formula—

$$2(2RO,\ SiO_3) + 5(2Al_2O_3,\ 3SiO_3) + 10HO.$$

Several analyses have been made of minerals almost identical in composition with this, as will be seen from the annexed table:—

	a.	*b.*	*c.*	*d.*
SiO_3, ...	48·20	50 00	66·12	52·40
Al_2O_3, ...	33·92	33·93	19·67	31·94
Fe_2O_3, ...	1·88	—	—	1 23
KO, ...	8·52	7·17	10·09 (by dif.)	5·41
NaO, ...	0·60	0·90		1·73
CaO,.	0·64	trace	1·12	—
MgO, ...	0·68	1·53	—	1·44
LiO,.	0·04	—	—	—
HO,.	6·00	4·79	3·00	5·00
	100·48	98·32	100·00	99·16

a Is the mineral under consideration.
b, A steatitic mineral, Agalmatolite, from Luganure.
c, A similar mineral from Dundrum; analyzed by Mr. England. Both of these last are given in a paper read before this Society by the Rev. Professor Haughton, in 1854.*
d, An analysis of Lithomarge from Schlackenwalde, in Bohemia.†

The formation of all these minerals appears to be due to the decomposition of feldspar.

Mr. Sterry Hunt, in his paper read last session before this Society,‡ ascribes the decomposition of earthy and alkaline silicates to the combined influence of water and carbonic acid, assuming that there was formerly a greater abundance of carbonic acid than at present, and a higher temperature (?). Thus alkaline and earthy carbonates are formed and carried off, and, the feldspar gradually decomposing, nothing at last would remain but a hydrous silicate of alumina or kaolin.

This reduction of feldspar may be shown by symbols thus:—

The empirical formula for orthose is—

$RO,\ Q_2O_3,\ 4SiO_3$, or 3 atoms, give $3RO,\ 3Q_2O_3,\ 12SiO_3$: in order to

* "Journal," vol. vi., p. 176.
† Rammelsberg, "Handbuch der Mineral-Chemie," p. 576.
‡ Page 85.

form from this kaolin, or $3Q_2O_3$, $4SiO_3 + 6HO$, a soluble silicate, $3RO$, $8SiO_3$, must have been removed.

In the mineral before us the process has been checked before it reached this point. Assuming that it is derived from orthoclase feldspar, and taking its empirical formula, and comparing it with the empirical formula of the feldspar, we find :—

$$\begin{array}{rccc} & 10RO, & 10Q_2O_3 & 40SiO_3 \\ \text{and} & 4RO, & 10Q_2O_3 & 16SiO_3 \\ \hline & 6RO, & & 24SiO_3 \end{array}$$

or 6 atoms of a silicate, RO, $4SiO_3$, have been removed.

There is, finally, one other circumstance worthy of remark with respect to these minerals. They all, without exception, no matter to what length the decomposition may have proceeded, have assimilated a variable quantity of water, some in a greater and some in a lesser degree; and this is the more remarkable as the amount of water entering into combination appears to be entirely independent of the relation of the mineral to the feldspar from which it was derived.

XVI.—Note on the Occurrence of Exogenous Wood in the Arenaceous Limestone of the Yellow Sandstone Series of the North Coast of Mayo. By the Rev. Samuel Haughton, M. D., F. R. S., Fellow of Trinity College, Dublin.

[Read April 8, 1863.]

The interest attaching to the geology of the north coast of Mayo has not decreased since our attention was first attracted to some of its principal features by the various communications and examinations of Sir Richard Griffith; and it may be desirable, in connexion with the notice of the remarkable specimen now before us, which I propose to lay before the Society, to retrace the general geology of the district, with a view of showing the relation subsisting between the several members of the North Mayo series, and especially their connexion with the plant beds under consideration, which occupy so low a position in the general series. Commencing at the Belberg River, we have the succession of the mica schist and quartzite series, dipping principally to the S. E., and these rocks extend as far south as Achill and Clare Islands; and on the north coast of Mayo as far east as the Glenglassera River, where they are succeeded unconformably by horizontally undulating beds of the Lower Carboniferous rocks, or "*Yellow Sandstone.*" I may here observe that this junction affords one of the most instructive examples of unconformity that can be desired (being very similar to that of Mount Misery, in the county of Waterford), as the Carboniferous rocks inclining, though at a lower angle, with the underlying mica

slate series, rest on these latter in such a manner as that the junction of the planes of the Carboniferous rocks with the oblique edges of the lower strata can be examined with great minuteness. The schistose series is immediately succeeded by red sandstones and shales, which form the base of the Carboniferous rocks of the district, though marked on Sir R. Griffith's Map of Ireland as "Devonian,"—a term denoting a phantom formation, and not possessing any significance in reference to Ireland, where the Palæozoic strata are naturally divisible into Silurian and Carboniferous. But it should be observed, in justice to Sir Richard Griffith, who has often expressed his opinions on this subject, that in the construction of his map he has compromised his own views in order to meet some of the established prejudices of English geologists, having, as stated in many of his papers, agreed to pursue the limits of the Carboniferous system no lower than the last occurrence of plants, however conformable all the subjacent strata may be.

I cannot, however, say that I disapprove of separate colouring for these older red sandstones as distinguished from others, whether red or yellow, as I always thought that (of course adopting obvious and local stratigraphical subdivisions for conventional reference), the more purely lithological and mineral was the character of our geological maps, the better, especially as distinguished from those laid down merely on certain arbitrary geological principles, many of which are still the subject of sharp controversial trial; for well observed lithological maps, besides their usefulness, put us in much better humour by the compliment they pay us in allowing us to infer our own geology.

To pursue the geology of this district rapidly, the first plant beds met with are those of the Glenbehy River, in the red and yellow shales, of which numerous fern stems and bivalves are scattered in all directions; and as we proceed in an eastern direction, the arenaceous limestones and shales of Glenulra River, containing marine mollusca and fish remains, succeed the plant beds I have referred to, and are again repeated with red and yellow shales at Doonfeeny, Bunatrahir Bay, and as far east as the imposing promontory called Downpatrick Head,* where they are interstratified with white sandstones, containing plants, which are again succeeded at Carrowcor by arenaceous shales and limestones, weathering yellow, and characterized by a profusion of the ordinary Carboniferous fossils, with fish remains—such as Euomphalus, Orthoceras, Producta, Spirifer, Terebratula, numerous Bivalves, Palæchinus, Turbinolia, &c., together with Psammodus, *Cladodus mirabilis*, Ctenacanthus,—accompanied by the plants under consideration, the whole suite forming the perfect equivalent, and no doubt even the continuation, of the Donegal series which flanks the shores of Mac Swyne's and Donegal Bays.

* I have always thought that the almost inaccessible island, inhabited by cormorants, called Doonbristy, once the continuation of Downpatrick Head (itself undermined by the sea), is well worth the trouble of a visit, as exhibiting a section of these sandstones limestones, and shales.

I have said that the Donegal and Mayo series are not merely equivalent, but absolutely identical; and the proof of this rests in fact wholly on the plants, which occur in great profusion in the shales, sandstones, and limestones of each coast, the marine Fauna of both being also similar. The plant to which I would draw your attention has been selected from others equally interesting, as occurring in the arenaceous limestone strata of Carrowcor, already mentioned—such as Stigmaria, Sigillaria, Knorria, Lepidodendron, or Sagenaria, and countless scattered fragments, all in such a high degree of carbonization as frequently to form pure pencil charcoal—has been selected, I say, principally, owing to a suspicion of its true nature, which could more readily be ascertained with accuracy from the facilities it afforded of making a microscopic preparation, which has been done* (as now exhibited in the diagram before us) by my friend Dr. John Barker, who describes it as presenting under the microscope an appearance similar to "*a bundle of rushes deprived of epidermis, containing elevated disk-like markings, the section having been amplified about* 500 *diameters.*"

I need hardly say that by the terms of this description we are at once enabled to identify the plant as a coniferous exogen, the rush-like appearance being the longitudinal tubes, with the areolæ or warts on the interior surfaces of their walls, while the concentric lines of growth (numbering in this specimen sixteen, and marking the age of the plant), are crossed by the medullary rays which are so characteristic of the whole order of coniferous plants; and as there can be no doubt of the inferior position of the arenaceous limestone in which it occurs, it becomes not only interesting, but highly important, to be made acquainted with the existence of true exogenous and coniferous wood, as undoubted as that of the Craigleith Quarry, so low down as the yellow sandstone of the north coast of Mayo is in the geological series.

There can be no just reason for supposing that the northern red and yellow sandstones, with their associated arenaceous shales and limestones, whether in Donegal, Mayo, or Fermanagh, occupy a higher position in the general geological scale than the red and yellow sandstones and Carboniferous slates of the south of Ireland, when we reflect that they contain the same marine mollusca and plants, including even Cyclopteris, identical with that of Kiltorcan, in the shales of Bunatrahir Bay, and at Ballycastle, as I am informed by Mr. Byron, of the Valuation Department, who sometimes accompanies Sir R. Griffith in his examinations, and is quite conversant with the north-western plant series. I have been shown by Mr. Byron a specimen of the Kiltorcan Cyclopteris, which he obtained in the black shales of Donegal, at Mac Swyne's Bay.

However cautiously we should venture upon the field of speculation, I think it may be assumed from the foregoing, with some degree of probability, that the plants in question were for the most part submerged *in situ*, as would appear to have been the case, for instance, with the

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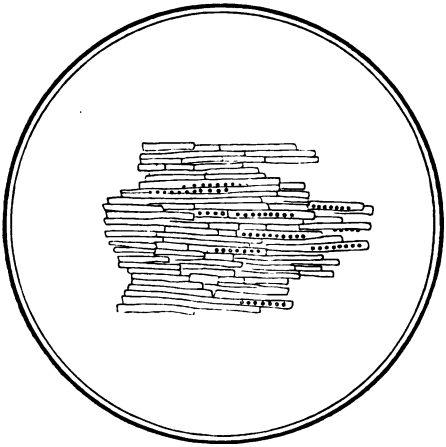
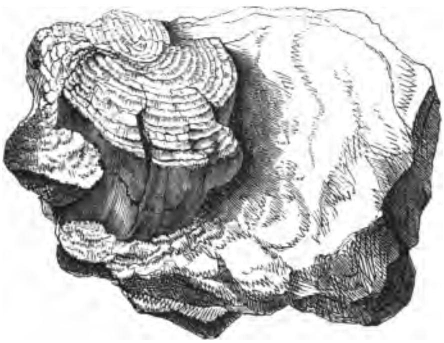
* See Plate X.



a.



b.

EXOGENOUS FOSSIL WOOD FROM THE LOWER CARBONIFEROUS LIMESTONE OF MAYO.

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a. Section. Magnified 250 times.
b. Specimen. Natural size.

TO ILLUSTRATE PROFESSOR HAUGHTON'S PAPER ON EXOGENOUS WOOD.

large specimen of Stigmaria from Mac Swyne's Bay, at present in the Museum of the Royal Dublin Society; as also with the thickly matted remains which occur in the black shale on the shore of Bruckless Bay, opposite Mr. Cassidy's tannery, though it is possible that the Mayo remains may only form a kind of outlying margin, surrounding the site of an ancient forest, now wholly submerged; from which, judging from their crushed and torn appearance, as well as by their comparatively sparing occurrence, they may have been removed by the action of water, especially if we reflect that in Mayo these plants consist of little more than fragments of stems and leaves, with (as in the instance before us) branches of charred wood, truncated or violently broken across, gigantic flattened roots, with rootlets (as at Mac Swyne's Bay), and shapeless patches of torn bark.

Sir Richard Griffith has informed me that Sphenopteris and Holoptychius (as at the River Banagh and Draperstown) were supposed to occur to the east of these beds at Kilcummin; and the latter of these fossils, if further proof were necessary, would only confirm the view I have taken with respect to the inferior position of the North Mayo series, which, in an unbroken succession, graduates upwards into the remarkable black oolitic limestones at Killala, and these are again regularly succeeded by the true Lower Carboniferous limestone of Ballina.

I may conclude by observing, that not far from Downpatrick Head, one of the most instructive instances of a trap dyke may be observed on the shore, which, like a solid wall, 6 or 7 feet thick, rises—say from 70 to 90 feet—out of the sea, cutting through the arenaceous limestone strata, but effecting neither the least disturbance of the strata on either side, nor apparently the slightest approach to metamorphic action.

XVII.—Observations on the Fossil Red Deer of Ireland, founded on the Skeletons found at Bohoe, in the County of Fermanagh, in 1863. By the Rev. Samuel Haughton, M. D., Fellow of Trinity College, Dublin.

[Read November 11, 1863.]

During the spring of the present year, in the drainage of a small lake, near Bohoe, in Fermanagh, a number of bones of Red Deer, with those of some other animals, were discovered in the sludge that lay under the bog through which the drainage operations were being carried on. These bones were secured by the Rev. William Steele, of Portora, and were by him presented to the Geological Museum of Trinity College.

The following list contains an enumeration of the bones found:—

RED DEER.

2 lower jaws.
5 individuals, { 2 heads, with antlers.
2 heads, without horns, and fragment of upper jaw. }
3 atlantes.
8 axes.

6 individuals,..
15 other cervical vertebræ.
66 dorsal and lumbar vertebræ.
4 sacra.
4 pelves.
91 ribs.
6 scapulæ, 3 right and 3 left.
9 humeri, 5 right and 4 left.
8 radii and ulnæ, 4 right and 4 left.
10 fibulæ and tibiæ, 6 right and 4 left.
6 metatarsal bones.
8 metacarpal bones.
7 sternal bones.
8 ossa calcis.
6 phalanges, and 2 hoofs.
18 tarsal and carpal bones.
25 fragments of Red Deer bones.

In addition to these bones, which were all those of the fossil Red Deer, there were found the following:—

1 right humerus of a young pig.
1 left femur of a calf (?).

These fossils were all found in marl underlying bog, in the same situation, geologically speaking, as that in which the *Cervus megaceros* has been always found in Ireland.

One of the ribs had been broken, and repaired, during life, with the production of long spiculæ, which must have caused the unfortunate brute much pain during the process of healing.

I was fortunate enough to be able to demonstrate the existence among these bones of two complete spinal columns, from an examination of which it became evident that the fossil Red Deer of Fermanagh had 14 ribs,—so that its vertebræ, as compared with the living Red Deer, are as follows:—

Fossil Red Deer.		*Recent Red Deer.*
7 cervical.	. . . .	7 cervical.
14 dorsal.	. . . .	13 dorsal.
5 lumbar.	. . . .	6 lumbar.
26		26

On examining the teeth, I found the posterior molars trilobate, while those of the recent Red Deer are, at least sometimes, only bilobate; however, on examining for me an excellent specimen of the recent Red Deer, preserved in the Museum of the Royal Dublin Society, Dr. A. Carte found the posterior molar of one side bilobate, and that of the other side trilobate,—thus demonstrating the trivial character of the lobation of the molars.

Two of the tarsal bones, also, were soldered together in both legs, while they are separate in the recent Red Deer; but upon this character I am not disposed to lay much stress, as it frequently occurs in the *Cervus megaceros*, and is probably the result either of old age, or of rheumatic disease of the ankle joint.

TO ILLUSTRATE PROFESSOR HAUGHTON'S PAPER ON THE FOSSIL RED DEER OF IRELAND.

It will be observed from the list of bones, that six individuals, at least, contributed their remains to the "find" of Bohoe bones.

These bones are considerably larger than those of the two skeletons of Red Deer to which I have had access, and are also larger than the corresponding bones of the fossil Reindeer in the Royal Dublin Society's Museum.

This fact, and the presence of 14 instead of 13 dorsal vertebræ, in two distinct specimens, indicate a considerable difference between the fossil Red Deer of Ireland and the existing Red Deer, and may justify the name by which the fossil Red Deer is known in some parts of Ireland, viz. the Marsh Deer, which is considered to be like, but not the same as the Red Deer.

The restored skeletons of the Fermanagh Red Deer are deposited in the Museums of Trinity College and of the Royal Dublin Society, and are well-worthy of the examination of anatomists. The skeleton preserved in the Museum of Trinity College is well represented in Plate XI., drawn from a photograph.

I believe that we are entitled to consider our fossil Red Deer a well-marked variety, and I would propose for it the provisional name of *Cervus elaphus*, var. *fossilis Hibernicus*.

XVIII.—On some Indentations in Bones of a Cervus megaceros, found in June, 1863, underneath a Bog near Legan, Co. Longford. By J. Beete Jukes, M. A., F. R. S.

[Read December 9, 1863.]

Legan is a small village, or hamlet, five miles south of Edgeworthstown. The surrounding country is very flat, the loftiest eminence within three or four miles of Legan being one of 365 feet above the sea, while the level of the nearest point of the adjacent River Inny is about 200 feet. The Inny flows from the north through a succession of wide bogs, and enters Lough Derevaragh about eight miles E. S. E. of Edgeworthstown, the level of the water of that lough being 211 feet above the sea. It leaves that lough within less than a mile of the point where it enters it, and soaks through other bogs into Lough Iron (204 feet above the sea); but almost immediately issues again from that lough, and flows slowly through more bogs to a point a mile and a half S. E. of Legan, and then turns more to the southward and westward on its course towards Ballymahon and Lough Ree, the surface of which latter lake is about 125 feet above the sea. A small brook runs by Legan towards the Inny through a shallow open valley of marshy and boggy ground, which is margined by drier gravelly land, rising with a gentle slope to a height of thirty or forty feet above the surrounding bogs. About half a mile south of Legan, on the western side of this little valley, is the old castle of Ardanragh, in the parish of Agharra; and in the flat to the S. E. of that, and between it and the Inny, is the bog from beneath which the bones to which I have to call your attention were procured.

It is important to observe that, if the whole of the peat bog of the district were to be entirely removed, and if the shell marl which generally lies below the peat bog were likewise to be carried away, their place would be occupied by widely spread sheets of shallow water, and the many existing pools and lakes would be connected together into one long irregular sheet of water, extending along the course of the Inny, with an occasional width of several miles, and resembling the present Lough Ree and Lough Derg on the course of the Shannon. Much of the present dry ground would either be islands or promontories in this widely spread water, the extent of which would only be sensibly diminished in the very driest seasons, when it would have time to drain itself into Lough Ree. The features which would be produced now by the removal of the shell marl, and the superincumbent peat bog, must necessarily be those which existed before the shell marl was deposited and the peat bog began to grow—provided that the levels of the country, and the form of the surface of the gravel-covered mounds and plains, were the same then as they are now. But we have no reason to suppose that the surface of the merely mineral (rocky and gravelly) depositions has undergone any material alteration during the accumulation of the organic covering which has gradually spread over the flatter parts of the country.

There is, however, this to be recollected, that while the presence of shell marl, full of pond and river shells, proves the former presence of fresh water over all the spaces where it occurs, and to a greater height than the level of the marl itself, the growth of peat bog may spread over parts that were formerly dry land, and may even raise the level of the adjacent lakes and rivers, by damming them up, and impeding the flow of the drainage of the country. The outline of the bogs, therefore, may give an exaggerated idea of the extent to which the district was formerly covered with water,—the old mean water line having probably been somewhere between the outline of the bogs and that of the shell marl beneath them. It must also be recollected that the level of the surface of the bogs is often far above that of the adjacent lakes at the present day, of which there is an instance in this very district. Glen Lough, three miles south by east of Edgeworthstown, has a level of 212 feet above the sea, while the surface of the bog to the north of the lake rises in one part to 260 feet, or 48 feet above the lake.

In some bogs a thickness of at least forty feet of peat seems to have accumulated above the surface of the old lake, on whose margin its growth originated. Mr. Shaw, of Ardanragh Castle, assured me that there was originally fifty feet of bog over the spot where these bones were found. Mr. Wilson, of Darraghmona, near Street, a few miles east of Edgeworthstown, informs me that many of the bogs in this neighbourhood (as in other parts of Ireland) have a thickness of forty feet of peat, and that shell marl is almost universally found beneath them.

The old castle of Ardanragh has been partially converted into a farmhouse, and is tenanted by Mr. Shaw, an educated and intelligent man, who farms the adjacent ground. We were indebted to him for the gift

of the skull and some of the bones of the specimen, and for assistance in procuring the rest. Mr. F. J. Foot, of the Geological Survey, being stationed at Athlone, in June, 1863, and having to examine the neighbourhood of Ballymahon, heard from Dr. Cahill, of Ballynacarrigy, of the recent discovery of some large bones underneath the bog near Ardanragh. He at once drove over, saw the skull, the right tibia showing the indentation, and the indented antler-tine (Plate XV., size of nature); and, by the kindness of Mr. Shaw, took them away with him. Mr. Shaw and the men who found the bones told him that there were other bones beneath the bog; and after communicating with me, and getting permission from the agent of Mr. King Harman, the owner of the ground, Mr. Foot proceeded on the 10th of July to have a more complete excavation made, the water thrown out, and as many of the other bones extracted as possible. He succeeded in procuring, in addition to the skull, and the indented tibia, and antler-tine, the following bones, as identified by Mr. Baily:—The left femur, with a deep transverse gash across it (see Plates XII., XIII., in which this bone is drawn half the size of nature); all the cervical vertebræ except the atlas; six dorsal vertebræ; eleven ribs; a scapula; both humeri, and radii, and the metacarpals; the right femur; the left tibia; the metatarsals; a tarsus, with the cuneiform bones; parts of two hooves; and many fragments of the horns.

The bones were found at a spot about 300 yards into the bog, and lay in shell marl, two or three feet thick, which rested on blue clay and gravel, in which there were angular or slightly rounded pebbles of limestone as big as the fist, the marl being covered, when Mr. Foot saw it, by fifteen feet of peat. Mr. Shaw subsequently assured us that two coatings of turf, each fourteen or fifteen feet thick, had been previously removed from the bog,—several old men now living in the neighbourhood recollecting the former removal of one cutting, which was then commonly known to have been the second cutting taken off.

The marl is a white, mealy substance (probably largely made up of Diatomaceæ), and full of shells, belonging, according to Mr. Foot's observations, chiefly to the species, *Cyclas cornea*, *Limnæa peregra*, and *Bithinia tentaculata*. From the lumps which I subsequently saw lying near the excavation, it appeared to have a laminated fibrous structure, and to be streaked with dark brown lines, apparently decomposed vegetable matter. The blue clay with gravel below I should judge to be the slightly waterworn surface of the ordinary limestone gravel of central Ireland. The shells I saw had lost their colour, but none of their lustre, and looked quite as fresh as the dead shells to be found in any pond at the present day, though much more brittle than living shells.

Having procured all the bones he could, Mr. Foot sent them up to the Geological Survey Office, where I saw them at the end of July. I was struck first of all by the great freshness of appearance in many of the bones, especially the skull and teeth, the incisor teeth looking almost as if recently extracted from a living animal. Some of the leg bones, however, while very fresh generally, had some of their

terminations entirely rotted away, and this was the case also with some of the ribs and the fragments of the horns. This is doubtless to be attributed to these parts having protruded above the marl, so that they decomposed either in the water that at first covered the marl, or in the peat which afterwards took its place (see Diagram, Plate XIV.). The most remarkable thing about them, however, was that in some of the best preserved bones there were sharp indentations, such as apparently could be produced solely by a cutting instrument. The most striking of these was the transverse gash, four inches long, and half an inch deep, across the lower end of the femur (Plate XII.). The sides of this indentation are not only sharply cut, but have on them marks somewhat like those produced by the sawing action of a knife, while the cancellated structure of the bone is not at all injured or distorted, the cells showing no sign of being squeezed either by a sudden blow or by any kind of pressure. The bottom of the cut terminates in an acute angle, which is also for the greater part quite clean and sharp, but a little ragged at one side. When first seen, this was still more ragged looking, as both Mr. Baily and myself observed a little piece of what I took for bone that had only been partially removed from the cut. As the bone dried, however, this little piece came out while in the hands of Mr. MacHenry (one of our fossil collectors), and we then found that it was certainly no part of the adjacent bone, but that it agreed in structure precisely with the edge of an antler (see Plate XII., *b*, *in which the little fragment is drawn of the natural size*).

The other most striking indentations were those on the tibia and antler-tine, which Mr. Foot procured along with the skull from Mr. Shaw, on his first visit to Ardanragh Castle, and of which he sent me a sketch at the time. These indentations are about two inches broad, and a quarter of an inch deep; and they looked as if they had been each chipped out with some sharp instrument.

The impression left on my mind from a first inspection was, that these three indentations were the best evidence that had yet turned up in proof of man having been contemporaneous in Ireland with the *Cervus megaceros*, and having left his marks upon the bones of an animal soon after its death, which he had himself probably killed.

The next morning, however, I again examined these remains, and I was then struck with the similarity in form between the indentation on the tibia and that on the antler-tine; and on putting them together, I found that they locked completely into each other, fitting with the most close and perfect adjustment. I had previously observed that the surfaces of these two indentations were stained with some irregular streaks of brown colouring matter, but I then perceived that the pattern of these streaks was precisely the same on each surface, and would, when in apposition, correspond as closely as the marks of an ink blot would on the opposite pages of a book, if they were squeezed together while it was yet wet. Moreover, there was a longitudinal crack or crevice on the surface of the tibia, running through the indentation, which at one part split into three little fissures; and on the surface of the antler there were three little wrinkles, or ridges, which exactly fitted into these

cracks.* In addition to this, a longitudinal ridge which runs along the outer side of the tibia is traceable also through the indentation, standing up as a slight prominence, and there is in the antler a corresponding hollow, or shallow groove, exactly fitting the prominence on the bone, like the cast of a mould. It was of course obvious that the perfect correspondence of these two surfaces could only be produced by their mutual pressure against each other, under such conditions as would allow each to receive the impress of the other; and it appeared to me that the whole amount of the indentation had been thus caused. But if the pressure of these parts against each other while saturated with moisture and under the load of forty feet of bog, through a great unknown period of time, produced the indentations in these bodies, may not the transverse gash in the femur, and the other marks which it exhibits, have been caused in the same way? It seems to me that they might. The little fragment of antler which was sticking in this gash, when first examined by Mr. Baily and myself, appears to me to have a great significance; and I believe it possible that this apparent cut was caused by the pressure of the sharp edge of an antler resting against it (as suggested in the Diagram, Plate XIV.).

The other marks are like abrasions at both ends of the femur, and at the upper end of the tibia. There are also two curious circular holes, like nail-holes, at each side of the principal condyle at the end of the femur near the gash, the holes being exactly opposite to each other (see Plate XIV.; one of these is also shown in Plate XII.) Some other marks are also observable on the side of the tibia, adjacent to the chief indentation. These are slight indentations with a polished surface, such as might be supposed to be caused by leather thongs tied tightly round the bone (see Plate XV.), except that these marks occur only on one side, and have no corresponding marks on the other side of the bone.

There is one circumstance to be especially observed with regard to all the marks which I have called indentations, and that is, that they have all been produced, not by the mere pushing in of the external surface, or by compression of the outer layers, but by the actual removal of a certain portion of the external parts, precisely as if those parts had been cut away. No one would indeed have supposed that any of these marks could have been caused by anything else than by cutting, if it had not been for the remarkable circumstance of the perfect fitting and the corresponding staining of the indented surfaces of the tibia and antler-tine. It is obvious that this minute correspondence could only have been produced by pressure, so that in this case the question is narrowed to the mere degree of the action. Was the whole indentation thus caused, or were the parts roughly fitted by cutting, and then subsequently adjusted to each other by pressure? I believe that it was

* Repeated trials at fitting these together have injured these cracks, so that they now no longer receive the ridges so perfectly as at first.

wholly caused by pressure; but the difficulty before mentioned still arises—the indentation in the tibia exhibits all round its margin a section of several successive layers of bone, in such a way as to show that the intervening portions of these layers have been absolutely removed. What became of these portions, and how were they removed?

It has been suggested to me that the indentations were first roughly made by human hands, and the antler-tine fastened across the tibia in the form of a cross, and that subsequent pressure on these bodies, thus adjusted, produced the minute correspondence of their surfaces.

If so, are we to suppose that this was done before the bones were buried in the marl, while the district was under water; and that the ancient hunter, having killed his prey, cleaved a leg bone of the animal, broke off a tine of his horns, adjusted them in the form of a cross, tied them firmly together, and then immediately threw them into the water along with the rest of the carcase, so that all the bones fell into the marl at the bottom together? Or are we to suppose that some person of later date, having fitted together some bones of another deer, took the trouble to dig down through the bog, clear out the water, and place these in the marl below, and cover everything up again carefully, so as to leave no mark of the excavation, and that in so doing he happened to hit on the very spot where the bones of another exactly similar deer, in precisely the same condition, were already lying?

Doubts have also been raised as to whether these indented bones were really found in the place we suppose, and whether they had these indentations at the time they were so found. In answer to these doubts, I can only say, that Mr. Foot and myself have carefully investigated the circumstances of the case, and are both fully convinced of the genuineness of the indentations, and that the bones were all found in the place stated.

I went, together with Mr. Foot, on the 25th of November last, to Ardanragh, to make fresh inquiries, and we took these indented bones with us, and questioned Mr. Shaw respecting them, and also Michael Green, one of the men by whom they were first found. Michael Green appeared to be an intelligent and trustworthy young man, and neither he nor any one else could have any interest in deceiving us. He said he was ready to make oath that the marks were on the bones when they were found, and that the reason why they brought up the indented tibia and antler-tine together with the skull to Mr. Shaw was on account of their having these curious marks on them. Mr. Shaw stated that he received the skull, and the indented tibia and the antler-tine, about half an hour after they were found, and kept them in his house till he gave them to Mr. Foot, a fortnight afterwards. He said that the discovery excited a good deal of wonder among the people who lived near the bog, none of whom had heard of such an occurrence before; and that, after bringing up the skull, &c., to him, some of them proposed to break open the skull to see the inside of it; while others wanted to fix it up on a post by the road-side, to frighten people; but that he, thinking it was a curiosity, begged them to leave it with him. He said that the men

who first brought him the skull, &c., told him that there were other bones, but they did not take the trouble to raise them all; and Michael Green said, that among those which they did take up he had observed the large bone with the gash across it, but that somebody threw it away at the time; and that when Mr. Foot came to superintend the excavation, it was picked up by one of the children out of a boghole close by.

Mr. Foot, in his letter to me of July 11, says that it took "five men from six in the morning till noon to shovel away the loose peat and drain off the water from the hole where the bones were originally found;" and in a subsequent letter he informs me, that they "dug down through two feet of shell marl and one foot of blue clay to the gravel. The remains were apparently confusedly mixed up, and lay partly in the blue clay and partly in the marl. They did not dig deeper than the gravel, but dug laterally, in all directions, for several feet, until no more bones could be found. During this operation, some children who were among the bystanders, in playing about, found two of the bones which the men had brought up on the former occasion. They were two large leg bones, and, to the best of my belief, one was the large bone which had the gash on it, and in which was afterwards observed by you a small fragment of antler. I did not observe this mark at the time, as the bone had a good deal of dry marl adhering to it."* Both Mr. Shaw and Michael Green, in our interview with them the other day, declared that, "however the marks were made, or whoever made them, they were on the bones at the time they were found."

With respect to the surfaces of the tibia and antler-tine, it is obvious that neither their perfect fitting nor their mutual staining could be produced artificially, or in a short space of time. It must also be recollected that it was only in a dry summer, like the last, that the hole could have been dug so deep without some pumping apparatus, and that the marl in which they were found could never have been dug into before without obvious traces of the excavation being left, since the smallest portion of the white marl would have been at once distinguishable among the black turf.

We may, therefore, feel assured that these indentations have either been produced by natural causes, while the bones have been lying buried in the marl underneath the bog, or that they were the work of man before they were so buried. If the latter was the case, we must date them back to a period when the features of the country, so far as the distribution of land and water is concerned, were very different from what they are now, and while the site of the bog beneath which they were found was occupied by a lake.

It is doubtless true that peat may, under certain favourable circumstances, be of comparatively rapid growth, but we cannot suppose that these peculiarly favourable circumstances were ever universal over a

* It must be recollected that Mr. Foot was anxious only to get a good specimen of *Cervus megaceros*, and was not thinking of any marks on the bones, or of their possible significance.

large area. An accumulation of a thickness of thirty or forty feet of peat over an area of fifty square miles would require, I should suppose, several thousand years at least.

We must also bear in mind that the *Cervus megaceros* was the contemporary of the mammoth, or woolly elephant, the woolly rhinoceros, the cave hyæna, the cave bear, and the cave lion, and a species of hippopotamus, all now extinct; and that the reindeer, the brown bear,* and other animals now extinct in Ireland, were living here at the time that the *Cervus megaceros* lived here.

Moreover, although it is now established that man also existed on the Continent and in England with some or all of the extinct animals mentioned above, there is as yet no proof that he was living in Ireland with any one of them, unless these or similar marks upon their bones should be that proof. The proofs of the contemporaneity of man and this assemblage of extinct animals obtained in England and on the Continent are less open to doubt than such marks, while the geological circumstances surrounding them point back to an antiquity far beyond the ken of the most remote traditions of human history.

To my mind, therefore, the date of the entire extinction of the *Cervus megaceros* must be referred to a period far more ancient than any that our ordinary human chronology contemplates, one at which we have no independent proof that Ireland was inhabited by man at all. I should, therefore, feel inclined to require the most convincing evidence of the contemporaneity of man and the *Cervus megaceros* in this country; and I must say that, although the evidence of these indentations at first sight seemed convincing, the subsequent appearance of the possibility of their being caused by natural action re-establishes my previous scepticism, and makes me decline at present to accept any mere mark, indentation, or apparent cut upon the bones of extinct animals, as proof of human agency.

If I am asked how it is possible that pressure, however long continued, or however applied, should cause the removal of parts of dead bones, I would frankly answer, that *I do not know*. I would, however, refer the inquirer on this point to the last Bakerian Lecture before the Royal Society of London, by Mr. Sorby, on the direct correlation between mechanical force and chemical action. I would also beg leave to add, that because an action is at present inexplicable, it does not follow that it will never be explained, especially when no direct inquiry or experiment has been directed towards the solution of the problem.

APPENDIX.

My friend and colleague, M. Gages, kindly examined for us a portion of a rib belonging to this skeleton, and communicated to me the following result of his analysis of it:—

* To these must now be added the polar bear (*Ursus maritimus*), of which the bones have been found in Lough Gur, and described by Dr. Carte at the meeting of the Society in January, 1864.

Organic matter (cartilage, &c.), ...	41·42
Earthy matters, carbonates, and phosphates of lime, &c., . . .	58·58
	100·00

The specific gravity of the bone was 1·788. On dissolving the bony matter of a rib, he produced the flexible cartilage as if from a recent bone.

On consulting the paper, published in 1825, by Dr. Hart, giving an account of his examination of the bones from which he constructed the skeleton of the *Cervus megaceros* in the Museum of the Royal Dublin Society, he gives an analysis of a part of the rib of that skeleton, made by Dr. W. Stokes, which is as follows:—

Animal matter, ...	42·87
Phosphates, carbonates, ...	57·13
	100·00

and, in a letter by Dr. Apjohn respecting it, it is stated, that "the bone was subjected for two days to the action of dilute muriatic acid. When examined at the end of this period, it had become as flexible as a recent bone submitted to the action of the same solvent. The periosteum was in some parts puffed out by carbonic acid gas, disengaged from the bone, and appeared to be in a perfect state of soundness."

On the same page, Dr. Hart gives the following note:—"A gentleman told me of a bonfire which was made of a heap of these bones, in a village of the county of Antrim, in celebration of the battle of Waterloo, and the bones were observed to give as good a blaze as the bones of horses, which are usually employed on such occasions." He also, at p. 18, alludes to the existence of fat, or adipocere, in the shaft of one of the bones mentioned in the letter of Archdeacon Maunsell, at p. 8, where it is stated to have blazed like a candle.

In the paper published in the first volume of our "Journal," Dr. Hart correctly refers the differences in the state of preservation of these remains to the different nature of the substances in which they were deposited; those buried in marl being almost perfectly preserved; those buried in peat losing their mineral, but retaining their animal constituents, so as in some cases to be cut through as easily as the peat itself; while those buried in sand or gravel have not only lost most of their animal matter, but the bones themselves are much decomposed "or light and crumbly on the surface."

Mr. Foot, when disinterring these remains, was struck with the fact that, while the bones were so very fresh, there was at the same time an absence of a large part of the skeleton—that he only got one scapula, for instance, and no pelvis at all. This, however, seems to be a common occurrence, for in the letter of Archdeacon Maunsell, given in Dr. Hart's paper (p. 11), it is stated that the bones of the numerous skeletons found in the marl underneath the bog of Rathcannon, near Bruff, county of Limerick, were equally scattered:—"In some places portions were found removed many yards from others, and in no instance were two bones

found lying close to each other. Their position, also, was singular—in one place two heads were found, with the antlers entwined in each other, and immediately under them a large blade bone; in another a very large head was discovered, and, although a most diligent search was made, no part of the skeleton found within some hundred yards; in another the jaw bones were found, and not the head."

In this case, Archdeacon Maunsell says, that, "the valley in which the remains were found contains about twenty plantation acres, and the soil consists of a stratum of peat about a foot thick; immediately under this a stratum of shell marl, varying from one and a half to two and a half feet in thickness; in this many of the shells retain their original colour and figure, and are not marine. Under the marl there is a bed of light blue clay; through this one of my workmen drove an iron rod in several places twelve feet deep, without meeting opposition." That locality, then, was evidently an old lake, partially filled by clay derived from the washing of the drift, then by marl derived from the decomposition of shells, and finally overgrown by peat.

It is easy to understand that the carcases of the animals drowned, or killed by the old wolves or bears, and floating into the lake, should, as they decomposed, drop part of their bones in one spot, and part in another. At page 8, Archdeacon Maunsell says, "I have also the skull of a dog of a large kind (or at least of a carnivorous animal), which I found lying close to some of the remains."

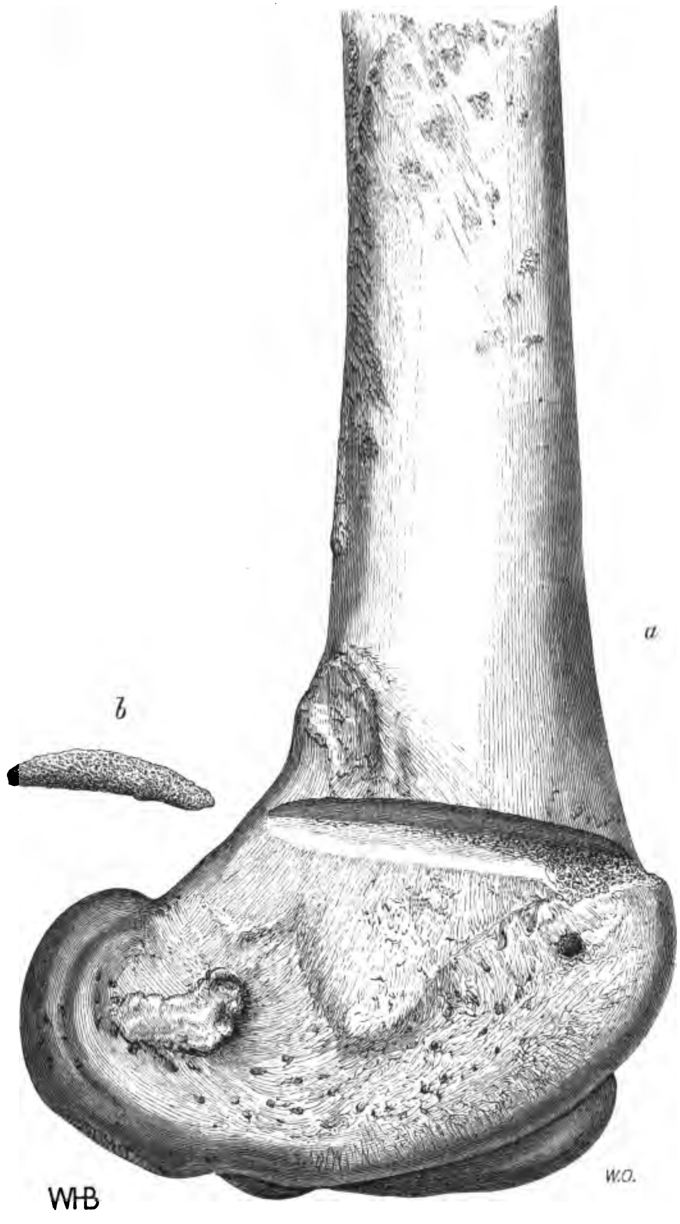
I would add, also, that it is by no means an uncommon occurrence to find indentations or abrasions on the fossil bones of the *Cervus megaceros*. Dr. John Barker, produced at the meeting of the Society, at which this paper was read, a number of bones from the Museum of the College of Surgeons, with abrasions upon them, like some of those on the bones from Legan; and Professor Haughton referred to similar marks on the bones of *Cervus megaceros* in the Museum of Trinity College.

DESCRIPTION OF THE PLATES.

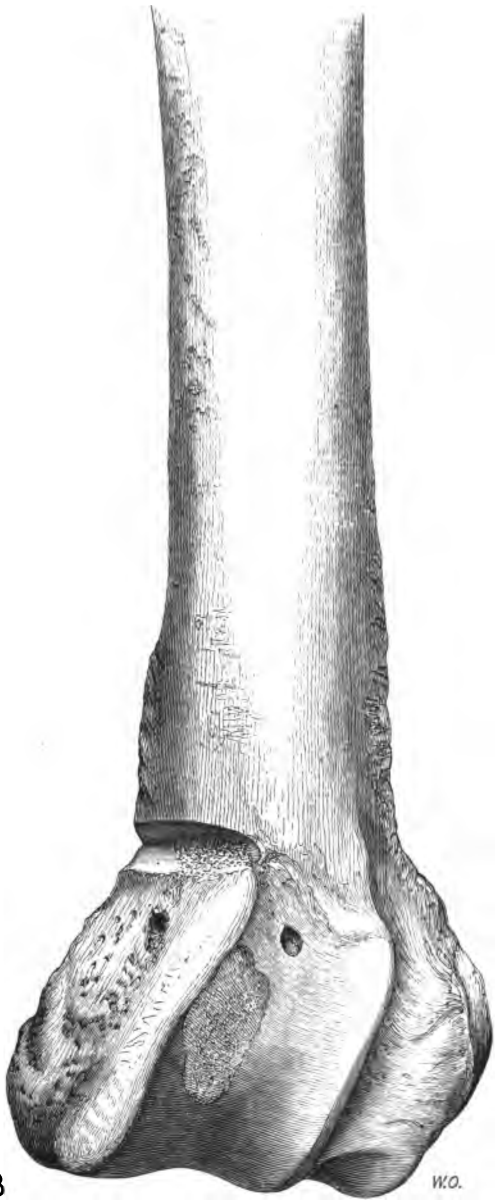
PLATE XII. (woodcut).—*a*, Sketch of the lower end of the left femur (half the natural size), showing a front view of the transverse gash, with one of the holes, like nail holes, underneath one corner of the gash; *b*, the small piece of antler (the natural size) which fell out of the ragged end of the gash above the hole, on the bones becoming dry.

PLATE XIII. (woodcut).—Sketch of the femur (half the natural size), showing a side view of the gash, with its ragged end, and the two holes like nail holes below it; as also an apparent abrasion on the surface of the condyle, below and between the two holes.

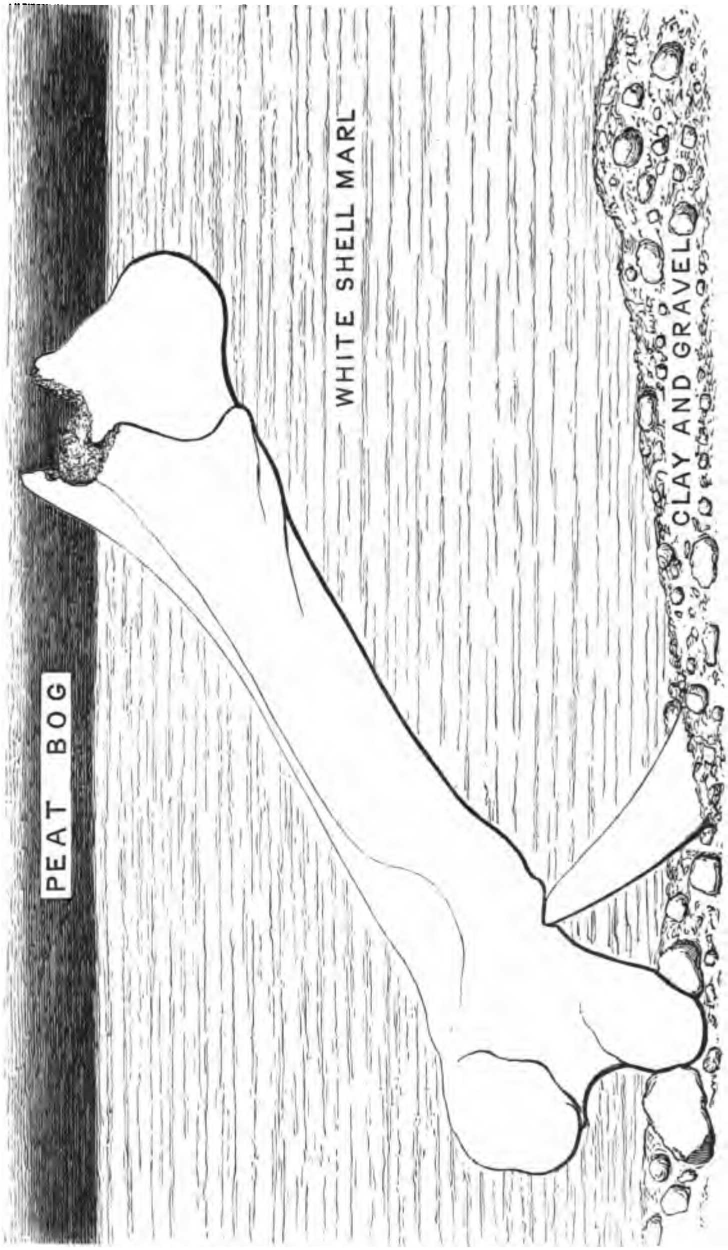
PLATE XIV. (woodcut).—An imaginary diagrammatic sketch of the way in which it may be supposed the femur lay in the marl, with its upper end protruding above it, so as to be rotted away, its lower end resting on the clay, which contained pebbles, that may have pro-



TO ILLUSTRATE MR. JUKES'S PAPER ON INDENTATIONS IN THE BONES OF A CERVUS MEGACEROS.



TO ILLUSTRATE MR. JUKES'S PAPER ON INDENTATIONS IN THE BONES OF A CERVUS MEGACEROS.



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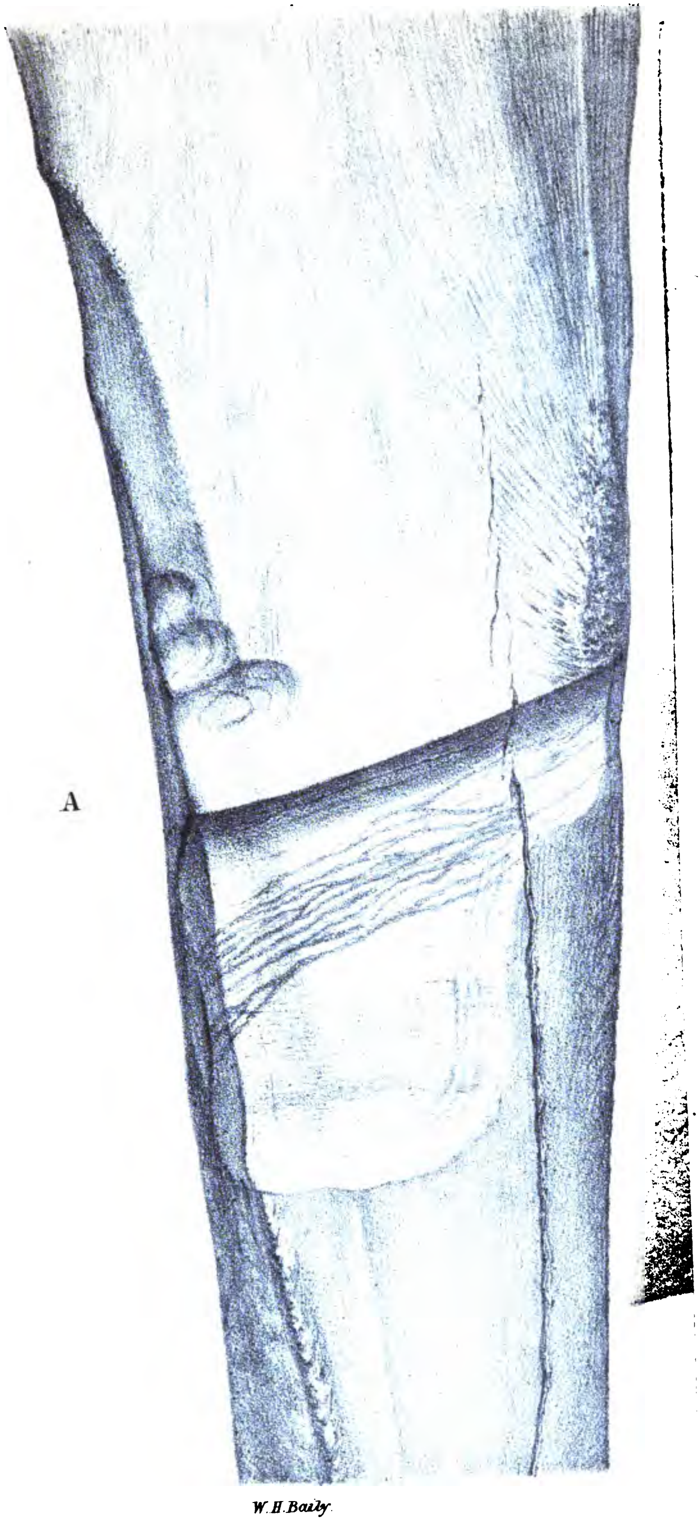

W. H. Baily.

duced by pressure the apparent abrasions; while a fragment of an antler may have come in contact with the bone, so that its sharp edge may, by long continued pressure, have produced the transverse gash.

PLATE XV. (lithograph).—A., Part of the tibia, of the natural size, showing the indentation, with the transverse streaks of staining, the longitudinal crack running along one side of the bone, and the ridge running near the other side of it, that ridge appearing even in the indentation, although less prominently than on the natural surface of the bone. The three small indentations on one side of the bone are also shown, and the concentric lines denoting the sections of the coats of the bone in all the indentations.

B.—Part of the tine of the antler, showing the indentation with the streaks of staining, corresponding to those on A, the furrow on one side of the indentation corresponding to the ridge on A, and the ridges or raised wrinkles on the other side of the indentation which fitted into the cracks on A.

C.—Lateral view of the indented part of A, showing the depth of the indentation, and the wearing of the side where the antler-tine wrapped over it, while the orifice in the bone below is uncompressed.

D.—View of the tibia and antler-tine when fitted on to each other, showing the way in which the antler-tine is partially embedded in the tibia, while itself indented so as on one side to embed the tibia.

XIX.—REPORT OF COUNCIL.

[Read at the Anniversary Meeting, February 10, 1864.]

THE Council have the pleasure of reporting to the Society, on the commencement of their thirty-third Session, that it continues in as flourishing a condition as heretofore, owing to the great activity and intelligence of its members. During the past year the Society has gained seven new members, and eight have resigned—some, we regret to say, from ill health. Three names have been removed from our list for non-payment of subscription; and three of our members have died, among whom the late Archbishop of Dublin must first be mentioned: he did not take any very active part in our proceedings, but was one of our original members, and sometimes honoured us with his presence at our meetings. It would hardly become us to enter into details of his literary labours, as even a catalogue of his works would exceed the space at our disposal, but we cannot let such a man pass away from us without saying a few words of regret at his loss. Mr. John Patten was also one of our original members, and has been taken from among us at the very advanced age of ninety-six; he was one of the original members of the Kirwanian Society, and well known for many years as the Librarian of the Royal

Dublin Society. We have also to deplore the loss of our esteemed friend Professor J. R. Kinahan, who died only a few days before our last anniversary, and we were then unable to state fully the important labours in which he had been engaged in the cause of science, and only briefly noticed his death. Since then William Andrews, Esq., has laid before the Natural History Society a most faithful account of the labours of their late Hon. Secretary in pursuit of his favourite studies as a naturalist, to which we beg to refer;* but we cannot let this opportunity pass without noticing some of the interesting discoveries which he made in that branch which more especially concerns us, during the comparatively short period he devoted himself to the pursuit of geology. The first paper he wrote on this subject was read before this Society on the 12th November, 1856 ("Journal," vol. vii., p. 184), and was entitled "On Annelidoid Tracks in the Rocks of Bray Head, county of Wicklow;" he there describes with his great accuracy and clearness of observation the Annelidoid Tracks which he found in the Cambrian rocks of Bray Head. "They occur," he says, "for the most part with the beds of Oldhamia, although there would not appear to be any actual connexion between the two. It appears nearly certain that some at least of the animals, whether molluscan or annelidian, by which these tubuli were made, must have lived not merely posterior to the death of the Oldhamia whose remains make up those layers, but even after a layer of mud on these remains." The next most valuable contribution to our science was Dr. Kinahan's celebrated treatise on the Genus Oldhamia, read before the Royal Irish Academy, 12th April, 1858, and found in vol. xxiii., page 547 of their "Transactions;" the object of this paper is best described by him in the following words:—"In certain schistose beds found at Bray Head and Howth are found markings of a very peculiar nature, occurring in mass, and now generally recognised as casts of an animal assemblage belonging either to the Polyzoan or Hydrozoan alliance. To seek out the probable zoological relations of these, and to describe the varieties which are found, is the intention of this paper." He then shows that these forms could not have been produced by crystallization; and after a short but interesting history of the discovery of this fossil, he proceeds to describe it in the following words:—"The species described by Forbes are so dissimilar in appearance, that it is questionable whether it would not be better to place them under separate genera, especially as there is a second type, like 'Old. antiqua,' which I propose to describe as distinct . . . . for which I propose the provisional name of 'discreta.' 'Old. antiqua' does not as a rule occur in thick masses, as the other species ('Old. radiata.') . . . . These facts would lead to the surmise that these were animals dwelling in a sandy sea bottom, mud being obnoxious to their existence." . . . He then refers to the annelidian tracks before mentioned as affording a strong proof of the former organic nature of these fossils, as the worms which formed them probably derived a

* "The Dublin Quarterly Journal of Science," No. xiii., p. 30.

great portion of their nourishment from these decomposing zoophytes. He then describes the characteristic features of each of the three species, and combats the idea that they were sea plants, and sums up his most valuable paper in these words:—"In the schist rocks of the Irish Cambrians, beds occur of considerable thickness, traceable continuously for many hundreds of yards, which are composed almost entirely of the polypidoms of an extinct sertularian, which occurs in connexion with other extinct aquatic types, such as annelids, mollusca (?), and asteroid polyps (?). That these fossils, judging from the almost absolute identity of one of them with the polypidom of a living sertularian type are more probably the polypidoms of extinct hydrozoa, than the cœnæcia of polyzoa; and that, judging from their state of preservation, their mode of occurrence in enormous masses, and the nature of the rocks in which they occur, they were originally the inhabitants of a comparatively still sea, and deposited by a gentle current on the shores of a shallow sandy bay."

Among Dr. Kinahan's other geological discoveries we may fairly consider that of the *Histioderma Hibernicum*, a new form of annelid, to be the most interesting and important. It was found by him at Bray Head, and the description, with a plate, is given in our "Journal," vol. viii., page 71.

Time does not permit us to refer more fully to all his writings; but his name will long be remembered by his friends as a truthful, generous and instructive companion, as well as one of the most ardent, painstaking, and skilful workers in the field of science.

During the session which has just elapsed, some papers of considerable interest have been laid before us. Among these a communication from Dr. T. Sterry Hunt, of Montreal, comes first on our list, as well in regard of the importance of the subject of which it treats, as also of its having been read at our first meeting in April. The members will recollect that no meeting was held in March, owing to the fact that the College gates were closed on the night of meeting.

The title of the paper was, "On the Chemical and Mineralogical Relations of Igneous Rocks;" and it contained the results of long investigations which its author had carried on, and of several previous communications of his which had been published in Silliman's "Journal," and in the "Quarterly Journal of the Geological Society of London." Dr. Hunt commenced by showing how, by the action of chemical and mechanical forces, the ordinary siliceo-aluminous sediments will be broken up into two classes, corresponding in their chemical constitution to the rocks formed from the magmas of Du Rocher and Bunsen, the existence of which beneath the surface of the earth is supposed by these petrologists. The tendency of the agencies of mineral springs, &c., which Dr. Hunt considers to exert a very important influence on the constitution of rocks, will be to form on the one hand a series of deposits characterized by the abundance of quartz and potash feldspar, while on the other hand the basic elements, such as lime, magnesia, and the oxides of iron, will be collected, so as to form a mass from which

hornblendes and basic feldspars, &c., may be formed. He then shows how the ordinary types of metamorphic sedimentary rocks will be produced from these two classes of sediments,—the potassiferous granites degenerating into quartzose mica slate, and ultimately to pyrophyllite slate, by the gradual removal of the alkali. Similarly, the basic deposits will give rise to rocks characterized by the abundance of iron and lime.

Dr. Hunt then applied the views propounded in the paper, to explain the formation of the different types of metamorphic rocks which have been to a great extent discovered by the labours of the Geological Survey of Canada.

He makes five principal subdivisions of these rocks:—

I. The Laurentian series, characterized by the abundance of a granitoid gneiss, and by the absence of mica and of ferruginous minerals.

II. The Labrador series, whose relations to the other rocks have been only recently ascertained. It contains a large amount of anorthosite rocks, and is unconformable with the subjacent Laurentian series.

III. The Quebec group, which are altered Lower Silurian Rocks.

IV. The Huronian series, the consideration of which was not brought forward in this paper.

V. The Metamorphic Palæozoic Rocks of more recent formation, belonging to the Upper Silurian and Devonian systems.

Dr. Hunt pointed out minute differences in chemical and mineralogical character between the rocks belonging to the respective series, and concluded by pointing out some particulars in which the rocks of Donegal and the Highlands of Scotland, which were brought under your notice during the sessions of 1861 and 1862, agreed with some of those found in Canada.

The Council cannot but congratulate the Society on having been the channel through which this paper was communicated to the geological public, and they hope that it may not be the last which they will receive from the same pen. Dr. Hunt has been elected an Honorary Member of the Society since the reading of the paper.

At the May meeting Mr. Close read a paper on Slickensides, in which he showed how loosely this term is in general applied, and how unsatisfactory the ordinary explanations are, which are assigned for the origin of the striated surfaces known by that name. By means of an extensive series of careful observations of the directions of these striations in the district of granite lying to the east of Shankhill and the Two-rock Mountain, he proceeds to show that these markings could not have been produced by motion of the rock, and that they are due to the crystallization of schorl and other minerals on the joint surfaces. He does not, however, himself assign a definite reason for the peculiar formation of this crystallization, but throws out a hint that it may have been connected with electrical or magnetical forces.

At the same meeting, Dr. Carte read a paper, which was the precursor of several interesting communications which have been made to us on the subject of the animal remains which are found in the superficial deposits of this country, and which point to the possible coexistence of

man in this island with animals which are now extinct. The paper in question was on the varieties of the reindeer which have been found fossil in Ireland; and Dr. Carte showed that most of the antlers of this animal which have been discovered exhibited a characteristic which is noticed by Sir John Richardson as peculiar to the barren ground caribou of the extreme north of North America. This consists in the development of the brow snag on one antler into a broad triangular vertical plate, as will be seen by reference to the plate illustrating the paper.

The fact of the previous existence in Ireland of a species so eminently arctic in its habitat as the barren ground reindeer is extremely remarkable, and derives strong confirmation from the fact that, since the paper of which we are speaking was read, Dr. Carte has proved that the Polar bear, *Ursus maritimus*, was also a member of our Irish Fauna.

At the same meeting Professor Haughton announced the discovery of several specimens of the red deer in the county of Fermanagh; and at the November meeting he gave an anatomical description of the skeleton which is now in the Museum which is under his charge.

Dr. Haughton considered that the subfossil specimen described by him was different in some respects from the animals which still exist in a wild condition in a few districts of Ireland and in Scotland, basing his opinion on the fact that the skeleton in question possessed fourteen ribs, instead of thirteen, the normal number. This peculiarity is, however, by some anatomists considered not to be of great importance. The greater size of the fossil antlers, as compared with the recent ones, admits of an easy explanation from the fact that the herds which now inhabit the deer forests of Scotland are in a more than half-tame condition, and that every fine head is at once marked down and taken for a trophy. On this subject we need only advert to the fact that our countryman, Lord Powerscourt, has brought over from Germany a pair of antlers, which for magnificence are utterly unequalled by anything found in these islands, either recent or fossil; and it is stated that in one of the castles on the Rhine there is a collection of heads several of which are even finer than that which he purchased.

In June a short paper was read by Mr. Scott on the fossils of the Yellow Sandstone of Mountcharles, county of Donegal, some of which are identical with those of the Coomhola grit of the south of Ireland, admitted to be Carboniferous in age.

At the same meeting Dr. Haughton gave us an abstract of his paper on Joints, which was read before the Royal Society, and was an attempt to establish from observation the fact that each great primary system of joints in rocks is accompanied by two secondary systems, lying at angles of about 30° at each side of the primary, and to prove that the existence of two such systems of faults is a necessary consequence of mechanical principles. His proofs from observation were derived from Cornwall, Mourne, Donegal, Fermanagh, and Waterford.

When the Society reassembled in November, we had, in addition to the account of the red deer, a paper by Mr. G. H. Kinahan of the Geo-

logical Survey, "On the Eskers of the Central Plain of Ireland." The author accounts for their formation by supposing the existence of ocean currents flowing in various directions (some of them at right angles to each other) over the island at the glacial epoch. According to him, these currents flowed in channels whose course is now marked by lines of depression across the country.

On the subject of the explanation of drift phenomena in general, by means of ocean currents, we cannot but observe that geologists appear to us to speak rather rashly when they talk about currents flowing in the open sea, in these latitudes, in any directions other than a N. E. or S. W. one. These are the only directions possible for currents in the north temperate zone, unless under the condition of the existence of an extensive mass of land either actually dry, or else very near the surface of the sea. This would oppose a barrier to the free motion of the water, and cause it to assume a direction different from that which would naturally be imparted to it by the rotation of the earth on its axis. An iceberg may have a N. W. motion, but this is given to it by its lee way when drifting with a N. or N. E. current, against a prevalent westerly wind. Mr. Kinahan makes three classes of Eskers,—*Fringe Eskers*, *Barrier Eskers*, and *Shoal Eskers*,—terms which explain themselves sufficiently. It is in long reefs of the first named class lying to the S.W. of Gort and elsewhere, "all of which are blunt towards the N. E., while they taper towards the S. W.," that he finds his chief evidence of the existence of his N. E. currents. He explains the different modifications produced in each class of Esker by local conditions, and illustrates his paper by carefully drawn sections.

The two concluding meetings of the session have been mainly taken up with the discussion of bones, as we first discussed Mr. Jukes' deer bones, and then Dr. Carte's bear bones. The subject of Mr. Jukes' communication, was the nature and possible origin of some markings which had been found on bones of the *Cervus megaceros*, discovered by Mr. Foot, of the Geological Survey, in the county of Longford, in the course of last summer. The marked bones consist of the left femur, right tibia, and an antler tine.

The femur exhibited a deep gash, four inches long, and half an inch deep across its lower end, and, in addition, two holes like nail holes, exactly opposite to each other, and at each side of one of the condyles. The gash was a clean cut, and quite smooth, exhibiting no marks of disturbance of the cancellated structure of the bone. It contained a very small fragment of an antler tine when first found.

The marks on the tibia and antler tine were broad and shallow indentations, highly polished; and on laying the two bones together, it was found that they fitted each other accurately, some stains on each surface corresponding "as closely as the marks of an ink blot would on the opposite pages of a book, if they were squeezed together while it was yet wet." Moreover, the unevenesses of surface exactly corresponded in the two bones.

At first Mr. Jukes was inclined to consider these cuts to be the best evidence hitherto obtained of the coexistence of man with the Megaceros in this island; but the fact of the perfect correspondence of the two cuts, which had not been at first noticed, caused him to change his opinion, and to assign a fortuitous juxtaposition of the two bones as a more probable origin for the markings. It appears to be conclusively proved that the markings were on the bones when they were first discovered; and with reference to the possibility of their having been made by some hunter just after he had killed the animal, Mr. Jukes expresses his opinion "that the date of the entire extinction of the *Cervus megaceros* must be referred to a period far more ancient than any that our ordinary human chronology contemplates—one at which we have no independent proof that Ireland was inhabited by man at all."

Mr. Jukes, accordingly, declines "at present to accept any mere mark, indentation, or apparent cut upon the bones of extinct animals, as proof of human agency."

The paper gave rise to a most animated discussion,—several other instances of cut bones having been adduced, and various causes assigned for the production of the markings in each case.

At our last meeting, in January, Dr. Carte brought forward some bones of the bear, which he has proved to be the Polar Bear (*U. maritimus*), and which were found at Lough Gur. At the same meeting Professor Haughton gave us the results of a calculation of the length of time which has elapsed between the first period at which organic life has been possible on the globe and the London Clay Epoch. He finds the period to be 1280,000,000 years, the calculation being based on physical data regarding the rate at which the earth would cool.

In consequence of the interest which has been excited by the discussions on the Mammalian fossils, to judge from the fulness of the attendance at our later meetings, one of the Hon. Secretaries, Mr. Scott, has prepared a catalogue of the more remarkable instances of the finding of Mammalian remains in Ireland, with a view of giving a concise summary of the information which has been brought forward on this subject at various times, both in this Society and elsewhere.

CATALOGUE.

Inasmuch as the subject of the Fossil, or rather Sub-Fossil Mammalia of Ireland, has been brought rather prominently before the notice of the Society during the past two sessions, I have considered that it might not be devoid of interest to our members, if I were to place on record the various genera and species of that class of which remains have been hitherto found in Ireland. Such a communication as this does not make any claim to originality, and I shall endeavour, as far as I can, to give my authority for every statement of a fact which will be embodied in this Catalogue. The chief sources from which the information has been derived are Dr. Scouler's papers, in our "Journal," and those by Dr. Ball and Sir W. Wilde, in the "Proceedings of the Royal Irish Academy."

The following list contains those of which notices remain on record:—

1. Ursus arctos.	9. Bos longifrons.
2. —— spelæus.	10. Cervus alces.
3. —— maritimus.	11. —— elaphus.
4. Canis lupus.	12. Megaceros Hibernicus.
5. Elephas.	13. Tarandus rangifer.
6. Hippopotamus.	14. Ovis.
7. Sus scrofa.	15. Cetaceans.
8. Bos frontosus.	

In this Catalogue I do not attempt to place on record the circumstances under which the remains have been found, unless in a few instances. To the list which I have given some more might be added; but these I do not consider to deserve the title of fossils,—such are the Fallow Deer, with many instances of Cetacean remains. On this point I need only remind the members that a few years ago an Armadillo was discovered walking about in a field in the county of Meath, having been thrown out of a travelling menagerie, in an apparently dying condition. Another similar instance is to be found in the case of the skeleton of the Lion which was found in the county of Carlow. Fortunately, before this account of this addition to our Irish fossil Fauna was quite ready for publication, an old man turned up who remembered the fact of a dead Lion having been thrown out of a menagerie some sixty years before, which, after having been skinned, was buried in the field.

Bears.—Three species of bears have been hitherto discovered in Ireland, and the progress of geological discovery has been more rapid in respect of this animal than of any other. In 1843, Dr. Scouler noticed that no Bears had been observed in Ireland, and in the year 1846 the discovery of no less than four skulls had been placed on record. There is no record of the existence of Bears in Ireland, as is remarked by Dr. Scouler in his paper on the animals which have disappeared from Ireland.* The oft-quoted statement of St. Donatus, who died in 840, is considered conclusive on this point:—

> "Ursorum rabies nulla est ibi, sæva leonum
> Semina nec unquam Scotica terra tulit,
> Nulla venena nocent, nec serpens serpit in herbâ,
> Nec conquesta canit garrula rana lacu."

The remaining evidence on the subject is entirely negative, and is derived from Giraldus Cambrensis and others. On the other hand, Sir W. Wilde† mentions that there is an Irish name for the animal in an old glossary in the Library of Trinity College, and Thompson mentions the existence of traditions of the animal.

In tracing the fossil Bears, I have derived much assistance from my friend, Dr. W. Frazer, one of our members, who has interested himself much in the matter.

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* "Journal of the Geological Society of Dublin," vol. i., p. 228.
† "Proceedings of the Royal Irish Academy," vol. vii., p. 193.

Ursus arctos.—The first Bears' skulls were obtained by Mr. Underwood, who said that he found two in the county of Longford, in 1846. These were bought by A. W. Baker, Esq.

Dr. Ball was permitted to take casts of the two skulls, which he presented to the Royal Irish Academy in 1846;* and at the same time he presented a cast of a third skull, which was in the possession of Mr. Cooke, of Parsonstown, and is now in the British Museum. It was found in deepening a river, near Colonel Bernard's property, in the King's County. These casts are now at the Royal Dublin Society. These skulls Dr. Ball pronounced to be those of the brown Bear, *U. arctos*, and in this opinion he was confirmed by Professor Owen, to whom he submitted casts of the skulls.

Mr. Gray discovered the skull of a bear, as described in the accompanying letter:—

"*Clonliffe Parade, January* 24, 1863.

"MY DEAR DOCTOR,—The bear's head to which you referred in your letter of the 10th instant, was found a little above Leinster Bridge, in the barony of Carberry, and county of Kildare. It was imbedded in peat or sand, about four feet below the surface, in a sort of valley or hollow, through which the River Boyne flowed; and if you refer to the fifth volume of the 'Proceedings of the Royal Irish Academy,' p. 53, of the Appendix, you will find a report of mine, describing a lot of articles found while engaged in the arterial drainage of some important rivers in Kildare, Meath, Westmeath, and the King's County. These are all in some degree descriptive of the locality; and if you are following up the subject, you may derive some ideas from the facts I have stated. The bear's head was got along with a great quantity of the bones and heads of the deer; and they were collected together in a position that would give the idea of their having been floated together, and deposited in an eddy or bend still of the river. There was a quantity of the bear's bones along with the head when it was found, but they were destroyed by the men who found them, *although they were not much decomposed.* Some of them were very short and strong—not such as you mentioned to me, but were, perhaps, nine inches in circumference, and about fifteen inches in length. They were destroyed by the men having used them to knock the earth out of the barrows, &c., by striking them till broken.

"There was no marl in the neighbourhood. If you refer to page 35 of Appendix to vol. v. of the Royal Irish Academy's 'Proceedings,' before referred to, you will have a description of the locality. The bone dirk (No. 15) alluded to was found about half a mile or less below where the bear's head was got, and in the same river course.

"I suppose you have seen the skull; it is in the Museum of the Academy, and I suspect about the most perfect of its class. Any other information I can afford you relative to such matters will afford me much pleasure; and I trust you will excuse my not having replied to your letter before this.

"Yours faithfully,

"*William Frazer, Esq., M. D.*" "RICHARD A. GRAY.

It was presented by him to the Royal Irish Academy, among the donations from the Board of Works, and is now at the Royal Dublin Society. It is figured by Sir W. Wilde.†

In March, 1859, Mr. Brenan and Dr. Carte discovered some remains of *U. arctos;* among others, a mutilated cranium, in the cave at Dun-

* "Proceedings of the Royal Irish Academy," vol. iv., p. 416.
† Ibid., vol. v., App., 54, vii.

garvan.* The other bones were—the left lower jaw, the atlas, two cervical, two dorsal, and two lumbar vertebræ, with several broken ribs.

About the year 1860, Mr. Going,† of Violet Hill, Broadford, county of Clare, discovered a skull, about twelve inches long, and of the shape of the skull of *U. arctos.*‡

Lastly, within the last year, Mr. W. H. Gregory, M. P., of Coole Park, near Gort, kindly offered to examine the caves in his park with Mr. Jukes, who has furnished me with the following account:—About 100 yards from the mouth of the cave, which is in low ground, and full of water in wet weather, a crust of stalagmite was broken through. This was in some places eight or ten inches thick; underneath it was an irregular mass of fine brown clay, from two to four feet thick. After digging out a great quantity of this clay, without finding anything at all, the bones of a small animal were at length met with, and among them a small fragment of a jaw, with two teeth in it. This fragment was afterwards examined by Mr. Blyth, and the teeth said to be the hindmost false molar (or carnassier), and the next false, or premolar, of a young Bear (*Ursus arctos*), being the deciduary or milk teeth of the right side of the upper jaw.§

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* "Journal of the Royal Dublin Society," vol. ii., p. 451.

† On applying to Mr. Going for further information on this subject, I received the following letter, which he has kindly permitted me to print:—

"*Violet Hill, Broadford, June* 20, 1864.

"SIR,—I beg to acknowledge the receipt of your letter of the 17th inst., and will feel happy at affording you all the information I can relative to the finding the animal remains you allude to in this locality.

"Some years since, my men, in draining a small boggy hollow, found a quantity of bones under the bog, in the blue clay. The bones were evidently those of some animal *much* larger than any dog, being stronger in proportion to their length, and exactly similar, as far as I and some friends could judge, to the skeleton of a large Bear. The skull was about twelve inches long, but the nose part was broken off, and very much resembled the *shape* of a badger's skull, but about the *size* of a large Bear's. Most unfortunately, I regret to state, these bones were not preserved. The skull was kept for some time, but has been lost; but for which I should have much pleasure in sending it for your examination. Near the place where these bones were found, in a few days after, two large *tusks*, about eight or nine inches long each, were also turned up, with several teeth also, besides some bones and skulls of other animals, which were found in a bog, in a wood, when raising some large *black* oak trees, several feet under the surface. The latter skulls resembled the first alluded to, but were of smaller size. I regret very much now that I have not preserved them, with the exception of an Elk's head and antler, which I have heard stated is the largest found in this county, but not in the same place in which other remains were discovered. All those I allude to were clearly belonging to extinct animals.

"I have the honour to remain, Sir,

"Your obedient servant,

"*R. H. Scott, Esq.*" "W. QUIN GOING.

‡ Explanation to Sheet 133 of the Map of the "Geological Survey of Ireland," p. 34.

§ With reference to this identification, I have to subjoin the following letter, received since from Mr. Jukes:—

U. spelæus.—Portions of the skeleton of this species, probably of a female specimen, were discovered among the other bones found at Shandon, Dungarvan. The cranium was not discovered, but the bones which were found exhibited the marked characteristics of *U. spelæus.*

U. maritimus.—At the January meeting of the Society, Dr. Carte announced the discovery of a few bones of an animal belonging to this species at Lough Gur. The recollection of his paper is so fresh, that I need hardly remind you of it. The account will be found at p. 114 of this volume. In this case, as in the foregoing, the cranium has not yet been found.

In Archdeacon Maunsell's well-known letter about the skeleton of the Megaceros at the Royal Dublin Society's Museum, printed in Dr. Harte's pamphlet, he mentions the discovery of a head of a large Dog, at least of a carnivorous animal, which was found with the Deer at Rathcannon, county of Limerick. It has been supposed by some to have been a Bear; but Archdeacon Maunsell would hardly have called it a Dog, if it did not closely resemble a Dog's skull.

Canis Lupus.—The remains of Wolves and Dogs can hardly be distinguished one from the other. There are several skulls of a canine type which have been found in Ireland; some of them are said to be those of Wolves. Several such specimens were obtained from Dunshaughlin.

The date of the extinction of Wolves is well known. In 1641, they were extremely troublesome. In 1652, a council order of Cromwell's government was made at Kilkenny, which prohibited the export of Wolf-dogs; and the reward for a bitch Wolf was £6; for a dog, £5. Smith, in his "History of Kerry," says the last was killed there in 1710. Mr. Hardiman, the editor of O'Flahertie's "Description of Iar-Connaught," pp. 10 and 180, gives some information on the subject, and says that the date of the death of the last Wolf in that district was 1700, as far as he could ascertain.

Elephas primigenius.—In the year 1715,* four teeth of an Elephant were found by Mr. Francis Nevil, at Maghery, eight miles from Belturbet, in sinking for the foundation of a mill. The finder did not know to what animal the teeth belonged, but suspected them to be Elephants' teeth; and this opinion was placed beyond a doubt by Dr. Thomas Molyneux, in an interesting letter, which follows the original communication.

"*Dublin, May* 10, 1864.

"MY DEAR MR. SCOTT,—I took over to London the other day the teeth which were found in Coole Park, and which Mr. Blyth informed me were those of a young brown Bear, and asked Professor Huxley to give me an opinion upon them. He examined them, and said they belonged to a young pig. So this case of the occurrence of *Ursus arctos* in Ireland fails.

"Yours very truly,

"J. B. JUKES."

* Boate, "Natural History of Ireland," p. 128.

In the year 1859,* Mr. E. Brenan, of Dungarvan, discovered a considerable portion of the skeleton of an Elephant in the cave at Shandon, near that town. These bones were associated with those of Bears and numerous other mammals.

In addition to these remains, Smith, in his "History of Waterford," p. 58, mentions the discovery of the rib of an Elephant within a mile of Whitechurch, not far from Dungarvan. He gives a figure of the rib, on a reduced scale, and it appears to resemble the rib of a Whale. It is quoted by Professor Oldham, in a paper read before the Geological Society of Dublin, on the 12th of June, 1844,† as the rib of a Whale, without any reason being assigned for its being so called.

Hippopotamus.—When the Ordnance Survey was in progress in the county of Antrim, in the vicinity of Carrickfergus a tusk of a Hippopotamus was found by a son of Mr. P. Doran, as will be seen from the accompanying letter, which I have received from my friend, Dr. David Moore, the Curator of the Glasnevin Botanical Gardens:—

"*Glasnevin, February* 5, 1864.

"MY DEAR SIR,—I have a clear recollection of the circumstance you mention about the tooth being found near Carrickfergus. Mr. Jukes applied to me some time ago to furnish him with all the information I could on the subject, which I did. The occurrence happened as follows:—In 1837, our office was in the Infantry Barracks, at Belfast. I had attached to my party several assistants, one of whom was the son of Mr. Patrick Doran, the mineral collector, whom I sent to Carrickfergus to collect plants, birds, fossils, &c. In his peregrinations he picked up the tooth in question, on the side of a stream, about a mile or less north-west of the town, on the rising ground towards the mountain. He described it to me as having been partly sticking out from a bed of gravel. I went to see the place afterwards, and, unless the locality be greatly altered since, would easily find it again. I gave the specimen (as was my duty) to General Portlock, who was then the commanding officer of the Geological and Natural History Departments.

"Faithfully yours,

"*R. H. Scott, Esq.*" "D. MOORE.

Sus.—A great number of Pigs' skulls have been discovered, especially in Lough Gur. These all belong to the old Irish long-faced variety, which is now fast disappearing. Many of them show the mark of the pole-axe on the forehead.

Bovidæ.—As regards the bovine animals, it has long been known that there are in Ireland two well-marked species of Oxen, whose remains are found fossil.

The gigantic species which is found in England, *Bos primigĕnius*, does not occur here, or at least has not been as yet discovered. The two species which are found, and of which specimens were presented by the Royal Irish Academy to the Royal Dublin Society, are the *Bos frontosus* of Nillson, and the smaller species, *Bos longifrons*. Several of the skulls exhibit the mark of the pole-axe.

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* "Journal of the Royal Dublin Society," vol. ii., p. 251.

† "Journal of the Geological Society of Dublin," vol. iii., p. 70.

In a recent communication made to the Royal Irish Academy,* Mr. Blyth stated that the skulls which he found here were exactly similar to those found at Uriconium.

Cervidæ. Cervus alces.—A horn of the true Elk is said by Thompson to have been found, in the county of Tyrone, by a relative of his own. It was dug out of a bog near Stewartstown, and was presented to the Natural History Society of Belfast. Mr. Thompson mentioned the discovery in the "Proceedings of the Zoological Society of London" for 1837, and this notice was copied into his "Natural History of Ireland." With reference to this, Dr. Carte has received the following letters from Mr. Robert Patterson, of Belfast, which he has permitted me to print:—

"*Belfast, February* 10, 1864.

"MY DEAR SIR,—As my friend, Mr. Hyndman, knew better than myself about the elk's horn in the Museum, I sent him your letter, and enclose his reply.

"Yours very sincerely,

"*Dr. Carte.*" "ROBERT PATTERSON.

"'*February* 9, 1864.

"'MY DEAR SIR,—I have examined the elk's horn in the Museum, and I think the freshness of it, and the perfection of the points or tangs, forbid the supposition that it could ever have remained any lengthened time in the bog. Besides the paint upon it, mentioned by Thompson, there is a round hole bored through the broad plate of the horn, showing that at some period it had been put up as an ornament in some person's hall. It must have got into its position in the bog by some accident.

"'Yours very truly,

"'*Robert Patterson, Esq.*'" "'GEORGE C. HYNDMAN.

This opinion of Mr. Hyndman has derived additional confirmation from a communication which I have received from a friend of mine, Mr. Bernard R. Ross, F. R. G. S., of the Hudson's Bay Company's Service, who, on examining the horn, pronounced it to be a North American specimen, and of no very great antiquity.

Cervus megaceros.—The instances of the discovery of this animal are so numerous, that I shall only give a few instances of their being found in juxtaposition with bones of other animals and with other articles.

It is, however, necessary to examine evidence of this nature with great care before receiving it. In the course of a discussion which took place before this Society on the 11th December, 1861,† some facts of interest were elicited. Dr. Petrie said that he had in his possession an iron sword which had been found, with the bones of a Megaceros, in the county of Meath; and Mr. Baily referred to the discovery of remains of the Megaceros which were found with spear-heads and pottery in a lake, in the canton of Berne, in Switzerland, as mentioned by Professor Morlot. The discovery of jet rings with the specimen in the Museum of the Royal Dublin Society, as noticed by Archdeacon Maunsell, was also alluded to. Two quotations from the "Book of Lismore" have also

* "Proceedings of the Royal Irish Academy," vol. viii., p. 472.

† "Journal of the Geological Society of Dublin," vol. ix., p. 339.

been recently brought under our notice, in which the chase of a large deer, supposed to be the Megaceros, is described. One of these was read on the evening to which we are referring, and the other in the course of Dr. Carte's paper on Lough Gur, which appears in this volume of the "Journal."

In a paper by Mr. H. Denny, of Leeds,* "On the Claims of the Gigantic Irish Deer to be considered as contemporary with Man," there is a long discussion on this subject, from which I extract the following statements, which I have not verified personally:—The leg of a Megaceros, with a portion of the tendons, skin, and hair on it, was found in the county of Wexford, on the estate of H. Grogan Morgan, Esq., at Johnstown Castle. This specimen was sent to the Royal Dublin Society, and was exhibited by Mr. Peall, Professor of Veterinary Surgery, at his lectures.†

A very scarce book—a "History of Ireland," which is said to be by Peppard, and was published in the seventeenth century—contains a statement to the effect, that the ancient Irish lived on the flesh of a great black Deer; and similar information is said to have been obtained by the late Sir W. Betham from some brass or bronze tablets, containing an inscription. This fact was mentioned by Mr. Glennon, of Suffolk-street, who with Mr. Richardson carried on a long discussion on this subject in 1846, in the "Zoologist," and elsewhere. Several instances of the finding of bones of the Megaceros in company with other remains are given by Mr. Denny, to whose paper I must refer you. In addition to the facts and statements just quoted, there is the evidence which may be derived from the existence of cuts, &c., on antlers and bones of the giant deer, which was discussed at considerable length by Mr. Jukes, and by the members who were present when his paper was read, in December last.‡

It will be seen from what I have mentioned, that the evidence on this subject is in an unsatisfactory state; and although it is certain that the date of the extinction of the Megaceros in Ireland is, geologically speaking, very recent, yet it is still a matter of opinion as to whether man was or was not the agent of its extermination.

Cervus elaphus.—The fossil Red Deer is as abundant as, and even more so than, the preceding species. Some of the antlers found are very magnificent. One obtained at Ballinderry Lake, county of Westmeath, presented to this Society by Mr. Hamilton, in 1843, had nineteen points. A hundred years ago they were still very abundant in Erris and in Kerry. In the ninth century, Giraldus speaks of them as very fat, and therefore unable to escape from their foes; and O'Flahertie, in his "De-

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* "Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire," vol. iii., p. 400.

† Unfortunately, this specimen appears to have been mislaid, and cannot now be found.

‡ "Journal," vol. x., p. 127.

scription of West Connaught," written in 1684, mentions them, p. 121. They are generally known under the name of Marsh Deer, and Professor Haughton is of opinion that they are a variety of the Red Deer.

Cervus Dama.—Among the bones presented by the Royal Irish Academy to the Royal Dublin Society, there is a fragment of an antler of a Fallow Deer, described as an antler of a young Red Deer in the "Catalogue of Unmanufactured Remains." This is evidently not a fossil, as the date of the introduction of the Fallow Deer into the Continent of Europe is known. Thompson mentions the discovery of a Fallow Deer in a bog in the county of Antrim. The specimen was in his possession.

A skeleton of a Fallow Deer, with a silver collar round its neck, was found at the same time as Mr. Cooke's Bear's skull, before referred to. It had belonged to some member of Lord Rosse's family.

Tarandus rangifer.—The history of all the specimens of this animal which have been discovered in Ireland was read before the Society in May, 1863, by Dr. Carte, and is printed in this volume of the "Journal," p. 103.

Ovis.—In the collection of Mammalian remains at the Royal Dublin Society, which have been deposited there by the Royal Irish Academy, there are several skulls of Sheep, and a few Goats' skulls. Of the Sheep there are two well marked types—one possessing several horns, like the polycerate Sheep, at present existing in Iceland, and the other identical with the horned Sheep of the Highlands of Scotland, according to the notice published by Dr. Blyth, and before referred to. The same authority considers the Goats' skulls to be very recent.

Cetaceans.—Professor Scouler found the rib of a Whale in the marl beds of Wexford, as mentioned in his Presidential Address for 1844.* In addition to this, remains of the smaller Cetaceans are not uncommon in localities near the sea side. There is a vertebra of a small Whale, or perhaps of a Porpoise, among the fossil bones in the Royal Irish Academy's collection. On this subject I may observe that a shoal of Ca'ing Whales was driven ashore some years ago on the sands to the west of Horn Head; the skeletons were buried in the sands.

The financial position of the Society may be reported to be in a satisfactory condition, although there is a small amount still due for bills of last year. The number of members shows a diminution as compared with last year; and we must only hope that, by the exertions of those who have the interest of our Society at heart, our number may be speedily filled up. The amount received from all sources during the past year was £110 2*s.* 2*d.*, and our expenditure during the same period has been £109 6*s.* 11*d.* The balance in hands at the commencement of 1863 has, therefore, been carried on almost intact to the present year. On the debit side of the account will be found an item of £8 6*s.* 6*d.*, being the amount realized by the sale of some material

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* "Journal," vol. iii., p. 18.

which had accumulated in the Library; and the proceeds of the sale were appropriated to the binding of upwards of 120 volumes of books, chiefly Journals, which in their unbound condition were inaccessible to the great body of our members, in consequence of the resolution of Council which does not allow books to be lent out before they are bound.

In the Appendix will be found, as usual:—

I. A list of Members now on the books of the Society.
II. ,, ,, gained and lost during the year.
III. ,, Donations received during the year.
IV. ,, Societies and Institutions to whom a copy of the Journal is regularly forwarded.
V. An abstract of the Treasurer's Account for the year 1863.

APPENDIX TO ANNUAL REPORT.

No. I.

LIST OF MEMBERS, CORRECTED TO JANUARY 31, 1864.

Members are requested to correct errors in this List, by letter to the REV. SAMUEL HAUGHTON, *Trinity College, Dublin.*

OFFICERS OF THE SOCIETY FOR THE YEAR 1864–5.

PRESIDENT.—Rev. H Lloyd, D. D., F. R. S., Vice-Provost.

VICE-PRESIDENTS.—Robert Callwell, Esq.; Joseph Beete Jukes, M. A., F. R. S.; Rev. S. Haughton, M. D., F. R. S., F. T. C. D.; Sir Richard Griffith, Bart., LL. D., F. G. S.; John Kelly, Esq.

TREASURERS.—Gilbert Sanders, Esq.; F. J. Sidney, LL. D.

SECRETARIES.—Robert H. Scott, M. A.; Robert S. Reeves, M. A.

COUNCIL.—James Apjohn, M. D., F. R. S.; Lord Talbot de Malahide, F. R. S.; John B. Doyle, Esq.; Alexander Carte, M. D.; W. H. Baily, F. G. S.; Alphonse Gages, M. R. I. A.; William Andrews, Esq.; B. B. Stoney, C. E.; John Barker, M. B.; Samuel Downing, LL. D.; John Good, Esq.; W. B. Brownrigg, Esq.; Capt. Meadows Taylor; W. Frazer, Esq.; Edward H. Bennett, M. B.; with the Honorary Officers.

HONORARY MEMBERS.

Elected.		
1844.	1.	Boué, M. Ami, For. Mem., L. G. S., *Paris.*
1861.	2.	Daubree, M., Membre de l'Institute, 91, *Rue de Greville, St. Germains, Paris.*
1861.	3.	Delesse, M., Ingenieur des Mines, *Paris.*
1861.	4.	De Serres, M. Marcel, *Montpelier.*
1861.	5.	Deville, M. Charles, *Paris.*
1861.	6.	Deville, M. Ste Claire, *Paris.*
1861.	7.	De Koninck, M. L., For. Mem., L. G. S., *Liege.*
1861.	8.	Geinitz, M. H. B., For. Mem., L. G. S., *Dresden.*
1863.	9.	Hunt, Dr. T. Sterry, F. R. S., *Montreal.*
1844.	10.	Lyell, Sir Charles, F. R. S., 53, *Harley-street, W., London.*
1861.	11.	M'Clintock, Sir Leopold, R. N., 21, *Merrion-square, North.*
1844.	12.	Murchison, Sir Roderick I., F. R. S., 16, *Belgrave-square, London, S. W.*
1832.	13.	Sedgwick, Rev. A., F. R. S., *Cambridge.*

HONORARY CORRESPONDING MEMBERS.

1859.	1.	Gordon, John, C. E., *India.*
1859.	2.	Hargrave, Henry J. B., C. E., *India.*
1859.	3.	Hime, John, C. E., *Ceylon.*
1858.	4.	Kingsmill, Thomas W., *Hong Kong.*
1855.	5.	Medlicott, Joseph, *India.*
1854.	6.	Oldham, Thomas, F. R. S., *Calcutta.*

MEMBERS WHO HAVE PAID LIFE COMPOSITION.

1853.	1.	Allen, Richard Purdy, 10, *Besboro'-terrace, N. C. Road.*
1861.	2.	Armstrong, Andrew, 16, *D'Olier-street.*
1861.	3.	Brown, Markham, *Connorree Mines, Ovoca.*
1857.	4.	Carson, Rev. Joseph, D. D., F. T. C. D., *Trinity College.*
1861.	5.	Connolly, J., *Kilmore, Artane.*
1832.	6.	Davis, Charles, M. D., 33, *York-street.*
1857.	7.	Dowse, Richard, *Mountjoy-square.*

Elected.
1861. 8. Fottrell, Edward, 86, *Harcourt-street.*
1862. 9. Frazer, W., M. D., 124, *Stephen's-green.*
1857. 10. Greene, John Ball, 6, *Ely-place.*
1857. 11. Haliday, A. H., A. M., F. L. S., M. R. I. A., *Harcourt-street.*
1831. 12. Hamilton, Sir W. R., *Observatory, Dunsink.*
1848. 13. Haughton, Rev. Professor, M. D., F. R. S., 40, *Trinity College.*
1862. 14. Henry, F. H., *Lodge Park, Straffan, Co. Kildare.*
1850. 15. Hone, Nathaniel, M. R. I. A., *St. Doulough's, Co. Dublin.*
1861. 16. Hone, Thomas, *Yapton, Monkstown.*
1831. 17. Hutton, Robert, F. G. S., *Putney Park, London.*
1851. 18. Jukes, Joseph Beete, F. R. S., 51, *Stephen's-green.*
1834. 19. King, Hon. James, M. R. I. A., *Mitchelstown.*
1856. 20. Lentaigne, John, M. D., *Great Denmark-street.*
1848. 21. Luby, Rev. Thomas, D. D., F. T. C. D., *Trinity College.*
1851. 22. Malahide, Lord Talbot de, F. R. S., *Malahide Castle, Malahide.*
1838. 23. Mallet, Robert, C. E., F. R. S., 1, *The Grove, Clapham-road, London.*
1846. 24. Murray, B. B., 6, *Martello-avenue, Kingstown.*
1859. 25. Ogilby, William, F. G. S., *Liscleen, Dunmanagh, Co. Tyrone.*
1849. 26. Sidney, F. J., LL. D., 19, *Herbert-street.*
1851. 27. Whitty, John Irvine, LL. D., 2, *Frederick-street, S.*

MEMBERS WHO HAVE PAID HALF LIFE COMPOSITION.

1831. 1. Baillie, Rev. James Kennedy, D. D., *Ardtrea, Stewartstown.*
1854. 2. Barnes, Edward, *Ballymurtagh, Co. Wicklow.*
1832. 3. Bryce, James, LL. D., F. G. S., *High School, Glasgow.*
1862. 4. Carter, T. S., *Wallington Park, Tilsworth.*
1855. 5. Clarke, Edward, M. D., 3, *Frankfort Buildings, Rathgar.*
1854. 6. Clemes, John, *Luganure Mine, Glendalough, Co. Wicklow.*
1857. 7. Crawford, Robert, C. E., *care of Messrs. Peto and Betts*, 9, *Great George's-street, Westminster.*
1861. 8. Crosbie, William, *Ardfert Abbey, Ardfert, Tralee.*
1861. 9. Dunaley, Lord, *Kilboy, Nenagh.*
1856. 10. Du Noyer, G. V., M. R. I. A., 51, *Stephen's-green.*
1832. 11. Dunraven, Earl of, F. R. S., *Adare, Co. Limerick.*
1836. 12. Enniskillen, Earl of, F. R. S., M. R. I. A., *Florence Court, Enniskillen.*
1844. 13. Esmonde, Sir Thomas, Bart., M. R. I. A., *Johnstown Castle, Wexford.*
1854. 14. Foot, Frederick J., 51, *Stephen's-green.*
1853. 15. Harkness, Professor, F. R. S., *Queen's College, Cork.*
1856. 16. Haughton, Lieut. John, R. A., *St. Helena.*
1857. 17. Haughton, John Hancock, Esq., *Carlow.*
1861. 18. Harte, W., C. E., *Donegal.*
1850. 19. Head, Henry, M. D., 7, *Fitzwilliam-square.*
1858. 20. Hill, J., C. E., *Tullamore.*
1862. 21. Hudson, R., F. R. S., F. L. S., *Clapham Common, London.*
1840. 22. Jackson, James E., *Tulliderry, Blackwatertown.*
1839. 23. James, Sir H., Colonel, R.E., F.R.S., *Ordnance Survey Office, Southampton.*
1832. 24. Kearney, Thomas, *Pallasgreen, Co. Limerick.*
1857. 25. Keane, Marcus, *Beech Park, Ennis, Co. Clare.*
1835. 26. Kelly, John, 51, *Stephen's-green.*
1853. 27. Kinahan, George H., 28, *D'Olier-street.*
1862. 28. Kincaid, Joseph, Jun., C. E., *Leinster-street.*
1838. 29. Larcom, Sir Thomas, R. E., LL. D., F. R. S., *Phœnix Park.*
1858. 30. Leech, Lieut.-Colonel, R. E., 3, *St. James's-square, London, S. W.*
1840. 31. Lindsay, Henry L., C. E., *Melbourne, care of J. Bower, Esq., C.E.*, 28, *South Frederick-street.*
1840. 32. Montgomery, James E., M. R. I. A.
1856. 33. Molony, C. P., Capt., 25th Regt., Madras N. I., *per Messrs. Grinlay and Co.*, 3, *Cornhill, London.*

Elected.
1856. 34. Medlicott, Henry, F. G. S., *Roarkee, Bombay, per Smith and Elder, Cornhill, London.*
1857. 35. M'Ivor, Rev. James, *Rectory, Moyle, Newtownstewart, Co. Tyrone.*
1845. 36. Neville, John, C. E., M. R. I, A., *Dundalk.*
1852. 37. O'Kelly, Joseph, 51, *Stephen's-green.*
1844. 38. Palmerston, Viscount, K.G., G.C.B., F.R.S., 4, *Carlton Gardens, London.*
1832. 39. Portlock, Major-Gen., R. E., F. R. S., *Lota, Cross-avenue, Blackrock.*
1832. 40. Renny, Henry L., R. E., *Canada.*
1854. 41. Smyth, W. W., F. R. S., *Jermyn-street, London.*
1832. 42. Tighe, Right Hon. William, *Woodstock, Innistiogue.*
1853. 43. Webster, William B., 104, *Grafton-street.*
1861. 44. Whitney, C. J., *Brisbane, Queensland.*
1846. 45. Willson, Walter, 51, *Stephen's green.*
1854. 46. Wyley, Andrew, 51, *Stephen's-green.*
1857. 47. Wynne, Arthur B., F. G. S., 51, *Stephen's-green.*

ANNUAL MEMBERS.

1861. 1. Andrews, William, *The Hill, Monkstown.*
1831. 2. Apjohn, James, M. D., F. R. S., *South-hill House, Blackrock.*
1857. 3. Baily, W. H., F. G. S., 51, *Stephen's-green.*
1857. 4. Bandon, Earl of, D. C. L., *Castle Bernard, Bandon, Co. Cork.*
1859. 5. Barker, John, M. B., 64, *Waterloo-road.*
1861. 6. Barrington, C. E., *Fassaroe, Bray.*
1862. 7. Barrington, E., *Fassaroe, Bray.*
1855 8. Barton, H. M., 5, *Foster-place.*
1862. 9. Barton, F., 2, *Grattan-street.*
1859. 10. Battersby, Francis, M. D., *Warrington-place.*
1844. 11. Bective, Earl of, *Headfort, Kells.*
1862. 12. Bennett, E., M. B., 2, *Upper Fitzwilliam-street.*
1861. 13. Blake, E. H., *Farmer's Club, Sackville-street.*
1857. 14. Bolton, George, Jun., 6, *Ely-place.*
1861. 15. Bolton, H. E., *Stranorlar, Co. Donegal.*
1831. 16. Brady, Right Hon. Maziere, Chancellor, 26, *Upper Pembroke-street.*
1861. 17. Brownrigg, W. B., 18, *Adelaide-road.*
1840. 18. Callwell, Robert, M. R. I. A., 25, *Herbert-place.*
1857. 19. Carte, Alexander, A. M., M. D., F. L. S., *Royal Dublin Society.*
1862. 20. Close, Rev. Maxwell, *Newtownpark, Blackrock.*
1858. 21. Cotton, Charles P., C. E., 11, *Lower Pembroke-street.*
1862. 22. Cousins, A. L., *Strandville, Clontarf.*
1834. 23. Croker, Charles P., M. D., 7, *Merrion-square, West.*
1863. 24. Crook, Rev. R., LL. D., 6, *Seaview-terrace, Simmons-court.*
1846. 25. D'Arcy, Matthew, M. R. I. A., *Anchor Brewery, Ussher-street.*
1863. 26. Dixon, G., 10, *Burlington-road.*
1849. 27. Downing, Samuel, C.E., LL. D., 6, *Trinity College.*
1852. 28. Doyle, J. B., *Grafton-street.*
1853. 29. De Vesci, Lord, *Abbeyleix House, Abbeyleix.*
1857. 30. Frith, R. J., C. E., *Leinster-road, Rathmines.*
1858. 31. Gages, Alphonse, M. R. I. A., 51, *Stephen's-green.*
1849. 32. Galbraith, Rev. Joseph A., F. T. C. D., *Trinity College.*
1856. 33. Ganley, Patrick, *Capel-street.*
1859. 34. Green, Murdock, 52, *Lower Sackville-street.*
1862. 35. Gribbon, C. P., 72, *Stephen's-green.*
1831. 36. Griffith, Sir R., Bart., LL. D., F. G. S., 2, *Fitzwilliam-place.*
1856. 37. Good, John, *City-quay.*
1857. 38. Hampton, Thomas, C. E., 6, *Ely-place.*
1861. 39. Hone, Joseph, Jun., 35, *Lower Leeson-street.*
1861. 40. Hudson, A., M. D., *Merrion-square.*

Elected.
1861. 41. Humphrey, H. T., *Woodview, Merrion-avenue.*
1861. 42. Hutton, E., M. D., 5, *Merrion-square.*
1834. 43. Hutton, Thomas, F. G. S., 116, *Summer-hill.*
1852. 44. Jellett, Rev. Professor, F. T. C. D., M. R. I. A., 9, *Trinity College.*
1842. 45. Jennings, F. M., M. R. I. A., F. G. S., *Brown-street, Cork.*
1861. 46. Johnston, C. F., 9, *Eustace-street.*
1862. 47. Kinahan, G., J. P., *Roebuck-hill, Dundrum.*
1861. 48. Lisabe, F., C. E., 42, *Sackville-street.*
1831. 49. Lloyd, Rev. Humphrey, D. D., F. R. S., S. F. T. C. D., 35, *Trinity College.*
1861. 50. Lyster, J., C. E., *Stillorgan Lodge, Stillorgan.*
1863. 51. Macalister, A., M. D., 10, *Gardiner's-place.*
1855. 52. M'Causland, Dominick, 12, *Fitzgibbon-street.*
1861. 53. M'Comas, A., 23, *Rathmines-road.*
1851. 54. M'Donnell, John, M. D., 4, *Gardiner's-row.*
1852. 55. Mac Donnell, Rev. Richard, D. D., Provost of Trinity College, *Provost's House, Trinity College.*
1837. 56. Mollan, John, M. D., 8, *Fitzwilliam-square, North.*
1851. 57. M'Dowell, George, F. T. C. D., 6, *Trinity College.*
1859. 58. Moore, Joseph Scott, *The Manor, Kilbride, Co. Dublin.*
1862. 59. Moore, Stephenson C., *Kenilworth-villa, Rathmines.*
1831. 60. Nicholson, John, M. R. I. A., *Balrath House, Kells.*
1856. 61. O'Brien, Octavius, 23, *Kildare-street.*
1863. 62. Ormsby, M. H., 16, *Fitzwilliam-square.*
1857. 63. Porter, William, C. E., *Leinster Club, Leinster-street.*
1861. 64. Ryan, George, 32, *Frederick-street.*
1857. 65. Reeves, R. S., 22, *Upper Mount-street.*
1861. 66. Roberts, W. G., *Ballinapark, Ovoca.*
1862. 67. Rowan, D. J., C. E., *Dundalk.*
1852. 68. Smith, Robert, M. D., 63, *Eccles-street.*
1852. 69. Sanders, Gilbert, M. R. I. A., 2, *Foster-place.*
1854. 70. Scott, Robert H., A. M., 18, *Ranelagh-road.*
1857. 71. Stack, Rev. Thomas, F. T. C. D., *Trinity College.*
1859. 72. Stokes, William, M. D., F. R. S., 5, *Merrion-square, N.*
1861. 73. Stoney, Bindon, C. E., 65, *Wellington-road.*
1857. 74. Tait, Alexander, C. E., *Queen's Elms, Belfast.*
1862. 75. Taylor, Captain Meadows, *Old-court, Harold's-cross.*
1862. 76. Trench, W. R., *University Club, Stephen's-green.*
1859. 77. Waldron, L., M. P., LL. D., *Ballybrack, Dalkey.*
1859. 78. Walker, William F., A. M., 9, *Trinity College.*
1863. 79. Westropp, W. H. S., 2, *Idrone-terrace, Blackrock.*
1859. 80. Wilde, Sir W. R., F. R. C. S. I., 1, *Merrion-square.*
1863. 81. Williams, R. P., 38, *Dame-street.*
1851. 82. Wright, Edward, LL. D., M. R. I. A., *Floraville, Donnybrook.*

ASSOCIATES FOR THE YEAR.

1. Bruncker, J., 16, *Trinity College.*
2. Ensor, C., 4, *George's-place.*
3. Freeman, G. F., 11, *Harcourt-terrace.*
4. Harman, G. F., 87, *Upper Dorset-street.*
5. Montgomery, H. B., *Church-avenue, Rathmines.*
6. Mullens, P., 32, *Charles-street.*
7. Russell, H., *Simmons-court.*
8. Stein, R., 136, *Leinster-road, Rathmines.*
9. Watson, W., 25, *Fitzwilliam-place.*
10. Woodward, R. C., 27, *Trinity College.*

No. II.

LIST OF MEMBERS GAINED AND LOST,

During the Year ending January 31, 1864.

MEMBERS GAINED.

Honorary Member.

1. Hunt, Dr. T. Sterry, *Montreal.*

Annual Members.

1. Crook, Rev. R., LL. D., 6, *Seaview-terrace, Simmons-court.*
2. Dixon, George, 10, *Burlington-road.*
3. Macalister, A., M. D., 10, *Gardiner's-place.*
4. Ormsby, M. H., 16, *Fitzwilliam-square.*
5. Westropp, W. H. S., 2, *Idrone-terrace, Blackrock.*
6. Williams, R. P., 38, *Dame-street.*

MEMBERS LOST.

Annual Members.

1. Harvey, Professor W. H., M. D., *Trinity College.* Resigned.
2. Jones, William, C. E., *Ely-place.* Do.
3. Joy, R., 33, *Mountjoy-square.* Do.
4. Morris, T. B., *Oaklands, Sandymount.* Do.
5. Patterson, B. T., C. E., 206, *Gt. Brunswick-street.* Do.
6. Petherick, John, F. G. S., *Surbiton, Kingston-on-Thames.* Do.
7. Still, Henry, C. E., 6, *Bessboro'-terrace, Circular-road, N.* Do.
8. Wright, E. Perceval, M. D., A. M., F. L. Z. SS., *Trinity College.* Do.
9. Dublin, The Archbishop of, *Stephen's-green.* Deceased.
10. Kinahan, J. R., M. D., *St. Kilda, Dalkey.* Do.
11. Patten, John, *Royal Dublin Society.* Do.

Removed from List, for Non-payment of Subscriptions.

1. Bermingham, J., *Millbrook, Tuam.*
2. Busteed, Dr., *Castle Gregory, Tralee.*
3. Fleming, L. J., C. E., *Henrietta-street.*
4. Lewis, F., C. E., *Sackville-street.*

State of the Society at the commencement of—

	Year 1863.	Year 1864.
Honorary Members,	12	13
Corresponding do.,	6	6
Life do.,	75	74
Annual do.,	90	82
	182	175

No. III.

DONATIONS RECEIVED TO JANUARY 31, 1864.

Amsterdam.—Verhandelingen der Kon. Akademie van Wetenschappen. Part 8.

——— Verslagen og Mededeelingen, Vols. XIII., XIV. Presented by the Academy.

Antwerp.—Bulletin de la Société Palæontologique de Belgique, Vol. I., pp. 81–128. Presented by the Society.

Berlin.—Zeitschrift für Allgemeine Erdkunde, Nos. 111–124. Presented by the Geographical Society.

——— Zeitschrift der Deutschen Geologischen Gesellschaft, Vol. XIV., Parts 3 and 4; Vol. XV., Parts 1 and 3. Presented by the Society.

Boston.—Proceedings of the Boston Natural History Society, Vol. IX., Sheets 4–11. Presented by the Society.

——— Boston Journal of Natural History, Vol. VII., Parts 2 and 3. Presented by the Boston Natural History Society.

——— By-Laws of the Boston Natural History Society.

——— Annual Report of the Museum of Comparative Zoology, 1862.

Brussels.—Annuaire de l'Academie Royale, 1863. Presented by the Academy.

——— Bulletin de l'Academie Royale, 1862. Presented by the Academy.

Caen.—Bulletin de la Société Linnéenne de Normandie, 1858-9.

Calcutta.—Annual Report of the Geological Society of India, 1861-2. Presented by Professor Oldham, Director.

——— Memoirs of the Geological Survey of India, Vol. IV., Part 1. Presented by Professor Oldham.

——— Palæontographica Indica, Vol. II., Parts 1–5. Presented by Professor Oldham.

Cherbourg.—Mémoires de la Société Impériale des Sciences Naturelles, Vol. VI., 1859. Presented by the Society.

Chicago.—Report of Lieut.-Colonel J. D. Graham on Mason and Dixon's Line.

Christiania.—Det K. Frederiks Universitets Halvhundert Aarsfest Sept. 1861. Beretning Aarsberetning, 1861.

Copenhagen.—Oversigt over det K. Danske videnskabernes Selskabs Förhandlingar, 1860–61.

Dijon.—Mémoires de l'Academie Impériale de Dijon, 1862. Presented by the Academy.

Dresden.—Sitzungsberichte der Naturwissenschaftlichen Gesellschaft Isis, 1862. Presented by the Society.

Dublin.—The Dublin Quarterly Journal of Science, Nos. 9–13. Presented by the Editor, Rev. Samuel Haughton, M. D.

——— Journal of the Royal Dublin Society, Nos. 29–30. Presented by the Society.

——— Proceedings of the Royal Irish Academy, Vol. VIII., Parts 3-6. Presented by the Academy.

——— Transactions of the Natural History Society of Dublin, Vol. IV., Part 1. Presented by the Society.

——— Sheet 15 of the Horizontal Sections of the Geological Survey of Ireland. Presented by Sir R. Murchison, Director-General.

——— Explanations to 9 Quarter Sheets of the Geological Survey of Ireland. Presented by Sir R. Murchison, Director-General.

——— Transactions of the Institute of Civil Engineers of Ireland, Vol. VII. Presented by the Institute.

Edinburgh.—Transactions of the Royal Scottish Society of Arts, Vol. VI., Part 3. Presented by the Society.

Falmouth.—Annual Report of the Royal Cornwall Polytechnic Society, 1862. Presented by the Society.

Halle.—Zeitschrift für die Gesammten Naturwissenschaften, Vols. XX., XXI. Presented by the Editors.

Kilkenny.—Proceedings and Papers of the Kilkenny and South-East of Ireland Archæological Society. Nos. 39–41.

Leeds.—Annual Report of the Philosophical and Literary Society for 1862–3. Presented by the Society.

——— Report of the Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire for 1862. Presented by the Society.

Leipsic.—Berichte über die Verhandlungen der Königlichen Sächsischen Gesellschaft der Wissenchaften, 1862. Presented by the Society.

Liverpool.—Transactions of the Historic Society of Lancashire and Cheshire, Vol. II. New Series. Presented by the Society.

London.—Quarterly Journal of the Geological Society, Nos. 73–77. Presented by the Society.

——— Proceedings of the Royal Geographical Society, Vol. VII., Parts 2–5. Presented by the Society.

——— Journal of the Royal Geographical Society, Vol. XXXII. Presented by the Society.

——— Notices of the Proceedings of the Royal Institution of Great Britain, Vol. IV., Parts 1, 2. Presented by the Institution.

——— Proceedings of the Royal Society, Nos. 53–59. Presented by the Society.

——— Report of the British Association, Cambridge, 1862. Presented by the Association.

——— Journal of the Proceedings of the Linnæan Society, Vol. VII., Parts 25–27. Presented by the Society.

——— The Mining and Smelting Magazine, Nos. 1–10, and 14–26. Presented by the Editor.

——— Catalogue of the Maps, &c., of the Ordnance Survey up to December 31, 1862. Presented by Sir H. James, Director-General.

Lyons.—Annales des Sciences Physiques et Naturelles, Vols. IV., V., VI. Presented by the Imperial Society of Agriculture, Lyons.

Manchester.—Transactions of the Manchester Geological Society, Vol. IV., Parts 4-12. Presented by the Society.

Milan.—Atti del Reale Instituto Lombardo de Scienze, Vol. III., Parts 9–14. Presented by the Institute.

Montreal.—The Canadian Naturalist and Geologist, and Proceedings of the Natural History Society of Montreal, Vol. VIII., Parts 1–6. Presented by the Society.

Munich.—Sitzungs-berichte der K. Baierischen Akad. der Wissenschaften zu München, 1862, Vol. II., Parts 2–4; 1863, Vol. I., Parts 1–4; Vol. II., Part 1. Presented by the Royal Academy of Munich.

——— Abhandlungen der Math-Physik; Classe. Vols. I., II., III., Parts 1–3; Vol. IV., Parts 1–3; Vol. V., Parts 1–3; Vol. VII., Parts 2, 3; Vol. IX., Part 3. Presented by the Royal Academy of Munich.

Newcastle.—Report on Coal Mining. Presented by the North of England Institute of Mining Engineers.

Newhaven.—The American Journal of Science and Art, Nos. 103, 104, 106–108. Presented by the Editors.

New York.—Fifteenth Annual Report of the Regents of the University.

Paris.—Annuaire des Sociétés Savantes, par M. le Comte Achmet d'Hericourt.

Philadelphia.—Proceedings of the Academy of Natural Sciences, Parts 1, 2, 7–12, 1862. Presented by the Academy.

——— Transactions of the American Philosophical Society, Vol. XII., Part 3. Presented by the Society.

——— Proceedings ...... Vol. IX., Nos. 68, 69. Presented by the Society.

Presburg.—Correspondenzblatt des Vereins für Naturkunde, 1862. Presented by the Association.

St. Louis.—Transactions of the Academy of Sciences, Vol. II., Part 1. Presented by the Academy.

Stockholm.—Ofversigt af K. Vetenskaps Akademiens Förhandlingen, Vols. XV. to XIX. Presented by the Academy.

Toronto.—The Canadian Journal of Industry, Science, and Art, Nos. 43–48. Presented by the Canadian Institute.
Truro.—Forty-fifth Annual Report of the Royal Institution of Cornwall.
Vienna.—Jahrbuch der K. K. Geologischen Reichsanstalt, Vol. XIII., Parts 1–3, and Index to first ten volumes. Presented by the Editor.
Washington.—Report of the Smithsonian Institution for 1861.
——— Report of the Patent Office for 1861.

PRESENTED BY THE AUTHORS.

Daubrée.—Mémoires sur les Depots Metallifères de la Suéde, et de la Norvége. By M. A. Daubrée.
——— Etudes et Experiences synthetiques, sur la Metamorphisme. By M. A. Daubrée.
Delesse.—Revue de Geologie pour 1861. By M. Delesse.
De Koninck.—De l'Influence de la Chimie sur la Progres de l'Industrie. By L. de Koninck.
——— Mémoires sur les Fossiles Palæozoiques recueillis dans l'Inde, par M. le Dr. Fleming.
Du Noyer.—On the Bituminous Coal of the Arigna District. By G. V. Du Noyer.
——— Notes on the Stratigraphical Position of the Giant's Causeway, and the Structure of the Basaltic Cliffs immediately adjoining it. By G. V. Du Noyer.
——— On the Evidences of Glacial Action over the South of Ireland during the Drift Period, and of a subsequent slight Alteration, followed by a Depression of the Land to its present Level. By G. V. Du Noyer.
Haidinger.—Coup d'Œil Géologique sur les Mines de la Monarchie Autrichienne. By W. Haidinger.
Hansen.—Darlegung der theoretischen Berechnung der in den Mond-tafeln angewandten Störungen. I. By P. A. Hansen.
Hennessy.—On the Relations of Science to Modern Civilization. A Lecture. By Professor H. Hennessy.
Hoch.—Supplementer til Dovre's Flora. By F. Hoch.
Jukes.—School Manual of Geology. By J. Beete Jukes, F. R. S.
Liebig.—Address on the 104th Anniversary of the Foundation of the University of Munich. By Baron Von Liebig.
Marcou.—Notes on the Cretaceous and Carboniferous Rocks of Texas. By Jules Marcou.
Marsh.—The Gold of Nova Scotia. By O. C. Marsh, A. B.
——— Catalogue of Mineral Localities in New Brunswick, Nova Scotia, and Newfoundland. By O. C. Marsh.
——— Description of a New Enaliosaurian (*Eosaurus Acadianus*), from the Coal Formation of Nova Scotia. By O. C. Marsh.
Mettenius.—Ueber den Bau von Angiopteris. By G. Mettenius.
Sars.—Geologiske og Zoologiske Jagttagelser. By M. Sars.
Wagner.—Memoir of Johann Andreas Wagner.

No. IV.

SOCIETIES AND INSTITUTIONS ENTITLED TO RECEIVE THE JOURNAL OF THE GEOLOGICAL SOCIETY OF DUBLIN.

ABERDEEN, .	University Library.
ALBANY, . .	State Library, New York.
AMSTERDAM, .	Royal Academy of Sciences.
BELFAST, . .	Queen's College Library.
BERLIN, . .	Royal Academy of Sciences.
	German Geographical Society.
	German Geological Society, per Besser'sche Buchhandlung, *Behrenstr.*, 7, *Berlin*.

Bologna, .	Academia della Scienze dell' Instituto.
Bordeaux, .	Imperial Academy of Sciences.
Boston, . .	American Academy.
	Natural History Society.
Bristol, . .	Institution for the Advancement of Science, Literature, and the Arts.
Brussels, .	Academy of Sciences.
Calcutta, .	Asiatic Society.
	Public Library.
	Geological Survey of India.
Cambridge, .	Philosophical Society.
	University Library.
Copenhagen,	Royal Society of Science.
Cork, . . .	Queen's College Library.
	Royal Institution.
Dijon, . . .	Academy of Sciences.
Dublin, . .	Royal College of Surgeons' Library.
	Royal Irish Academy.
	University Library.
	Royal Dublin Society.
	Natural History Society.
	Ordnance Survey Library.
	Professor Sullivan, as Editor of the "Atlantis."
	Geological Survey of Ireland.
	Institution of Civil Engineers.
Edinburgh, .	Royal Society.
	Wernerian Society.
	Society of Arts.
	University Library.
	Society of Antiquaries.
	Advocates' Library.
Falmouth, .	Royal Cornwall Polytechnic Society.
Florence, .	Society of Physics and Natural History.
Galway, . .	Queen's College Library.
Genoa, . .	Society of Physics.
Glasgow, . .	University.
Göttingen, .	University.
Halle, . .	Natur-forschende Gesellschaft.
Hanau, . .	Oberhessische Gesellschaft der Natur-und Heil-kunde.
Hanover, .	Royal Library
Kilkenny, .	Archæological Society.
Königsberg,	Königlich Physikalisch-Oekonomische Gesellschaft.
Lausanne, .	Société Vaudoise des Sciences Naturelles.
Leeds, . .	Geological and Polytechnic Society of the West Riding of Yorkshire.
	Philosophical and Literary Society.
Leipzic, . .	Royal Society of Sciences (Saxony).
	University.
Liverpool, .	The Literary and Philosophical Society.
	Historic Society of Lancashire and Cheshire.
London, . .	Geological Survey, *Jermyn-street.*
	British Museum.
	Society of Arts, *John-street, Adelphi.*
	Royal Institution, *Albemarle-street.*
	Royal Society, *Burlington House.*
	Geological Society, *Somerset House.*
	Linnean Society, *Burlington House.*
	Geographical Society, 15, *Whitehall-place.*
	Civil Engineers, Institution of, 25, *Great George's-street, Westminster.*
	Royal Asiatic Society, 5, *New Burlington-street.*

LONDON, . .	Royal College of Surgeons, *Lincoln's Inn.*
	Zoological Society, 11, *Hanover-square.*
	Athenæum, 14, *Wellington-street, Strand, W. C.*
	Anthropological Society, 4, *St. Martin's-place, W. C.*
	Mining and Smelting Magazine.
LYONS, . .	La Société Impériale d'Agriculture, d'Histoire Naturelle, et des Arts Utiles.
	Société Linnéen.
	Academie Impériale.
MADRID, . .	Academia de Ciencias.
MANCHESTER,	Literary and Philosophical Society of. [Sec., R. C. Christie.]
	Geological Society.
MELBOURNE, .	Philosophical Institute of Victoria.
MILAN, . .	Reale Instituto Lombardo di Scienzi.
MISSOURI, . .	State Survey and University, *Geological Rooms, Columbia, U. S. A.*
MODENA, . .	Imperial Institute of Science.
MONTREAL, .	Natural History Society.
MUNICH, . .	Royal Academy of Science (2 copies).
NEUCHATEL, .	Société des Sciences Naturelles.
NEW HAVEN,	The Editors of Silliman's Journal of Science and Art.
OXFORD, . .	Bodleian Library.
	Ashmolean Society.
PARIS, . .	Ecole Polytechnique.
	Geological Society.
	L'Ecole Impériale des Mines.
	Institute of France.
	Bibliothéque Impériale.
	Jardin des Plantes, Bibliothéque.
PHILADELPHIA,	American Philosophical Society.
	Natural History Society.
PLYMOUTH, .	Plymouth Institution and Devon and Cornwall Natural History Society.
QUEBEC, . .	Literary and Historical Society.
ROME, . . .	The Vatican Library.
ROUEN, . .	Academy of Science.
ST. ANDREWS,	University Library.
ST. LOUIS, . .	Academy of Sciences.
ST. PETERSBURG,	Imperial Academy.
	Central Physical Observatory of Russia.
	Russisch-Kaiserliche Mineralogische Gesellschaft.
STOCKHOLM, .	Royal Academy of Science, per Longman and Co., *Paternoster-row, London;* and Sampson and Wallis, *Stockholm.*
STRASBOURG, .	Société des Sciences Naturelles.
TORONTO, C.W.,	Canadian Institute, per Thomas Henning, Esq.
TOULOUSE, .	Academy of Sciences.
TURIN, . .	Royal Academy.
UPSALA, . .	Royal Society of Sciences.
VIENNA, . .	Imperial Academy of Sciences.
	Prof. W. Haidinger, of Vienna, as Editor of the "Jahrbuch der K. K. Geologischen Reichs-anstalt."
WASHINGTON,	Smithsonian Institute Library, per W. Wesley, Esq., 2, *Queen's Head, Passage, Paternoster-row, London, E. C.*
WINDSOR, .	The Royal Library.

No. V.

ABSTRACT OF TREASURER'S ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1863.

1863. Dr.				£	s.	d.
To Balance from last year's Account,				16	4	1
— Amount of Subscriptions received for year ending December 31, 1863:—						
— Life Compositions,	£10	0	0			
— Half-life Compositions,	5	0	0			
— Admission Fees,	6	0	0			
— Annual Subscriptions,	75	5	0			
				96	5	0
— Cash for Sale of Books,	9	11	3			
Less Commission,	1	4	9			
				8	6	6
— Cash for Sale of Maps,				2	10	0
— Amount of Dividend for one year on Government Stock,				3	0	8
				£126	6	3

1863. Cr.				£	s.	d.
— Mr. Oldham, Illustrations for Journal (per Draft 15,853),				8	5	0
— Sundries, (per Draft 4),	11	19	0			
— Porter's Wages,	7	17	6			
— Gratuity to Attendant,	1	10	0			
— Messrs. Hodges and Co., for Books,	3	9	6			
				24	16	0
— Assistant Secretary, half-year's Salary, to June 30, (per Draft 5),				10	0	0
— Mr. Cavenagh, for Binding (per Draft 6),	3	7	9			
Do., do.,	8	14	7			
				12	2	4
— Sundries (per Draft 7),	4	10	1			
— Porter's Wages,	6	12	6			
— Mr. Oldham, for Woodcuts,	1	12	6			
— Mr. Tallon's Account for Stationery,	1	13	6			
— Mr. Gill's Account for sundry Printing,	4	15	0			
				19	3	7
— Assistant Secretary, Half-year's Salary, to December 31, 1863 (per Draft 8),				10	0	0
— Mr. Gill, on Account of Printing Journal (per Draft 9),				25	0	0
				£109	6	11
— Balance in Bank,	£11	19	4			
— Cash in hands,	5	0	0			
				16	19	4
				£126	6	3

Audited February 3, 1864.—B. B. STONEY,
ROBERT REEVES.

G. SANDERS, *Treasurer.*
ROBERT CALLWELL, *Chairman.*

MINUTES OF PROCEEDINGS OF THE YEAR 1863-4.

General Meeting, April 8, 1863.

J. Beete Jukes, Esq., F. R. S., in the Chair.

The Minutes of the last meeting were read and confirmed, donations announced, and thanks voted.

H. G. Cooper, Esq., was elected an Associate Member.

Mr. H. E. Bolton exhibited his Model for illustrating the mode in which Buildings are overthrown by Earthquake Shocks. This model consisted of a frame of wood, with a square board suspended within it by tension cords of elastic Indian rubber. The board represented the surface of the earth, motion being communicated to it by means of a cord attached to one side, while the tension springs at the corners caused a horizontal vibration.

For the purpose of showing the manner in which fractures occur in buildings, he placed upon this "Seismic" Table four models of houses in succession, having their walls cut in sections.

No. 1 represented a cardinal building (using Mr. Mallet's nomenclature), or a rectangular house, having its side walls placed in a north and south direction: to this a "normal shock" (or that whose line of transit is parallel to either pair of walls) was applied, resulting in the fall of the end walls.

No. 2 represented a cardinal building, and was exposed to a subnormal (or an emergent normal) shock: the upper portion of the remote end of the building was cast down in this case.

No. 3, an ordinal building (or a rectangular house whose walls were not placed due north and south), was submitted to an abnormal shock, or a shock whose azimuth passed horizontally and diagonally through the building: the corners through which the shock passed were fissured vertically, and thrown down.

No. 4 illustrated an ordinal building: to this he applied a subabnormal (or an emergent abnormal) shock; the remote corner was fractured obliquely, and thrown off.

These experiments tended to prove that fractures and cracks occur transverse to the "wave-path." Overthrow and projection, on the contrary, take place in the line of "wave-path," which he illustrated by a model of a pillar having a rectangular base: this was found by experiment to fall in the direction of the wave transit. A violent shock produced the opposite result, owing to the base being carried with greater velocity through a larger arc, and the pillar fell in the opposite direction to the wave transit by reason of its own inertia.

A specimen of the sulphide of the new metal thallium was exhibited to the meeting, which had been prepared from copper ore from Bonmahon, in the county of Waterford, by Mr. Emerson J. Reynolds.

The Chairman said that, as Mr. Reynolds was present, he would request him to explain to the meeting the mode of preparation of the specimen.

Mr. Reynolds stated that he had been examining several Irish metallic ores for this metal, and that traces of it were to be found in some of them. The richest source which he had as yet discovered was the copper ore from Bonmahon, which was on the table. He then described the mode of the preparation of the sample, which weighed a few grains, and had been procured from about 4lbs. of ore. He hoped to be able to prepare more of this rare compound in the course of the summer, and to lay a more complete account of his researches before the Society on a future occasion.

Professor Haughton remarked on the interest of the specimen passed round, the first specimen of Irish thallium, or rather of its sulphuret. It appeared to him, as well as he could see by gas light, that the ore from which it had been obtained resembled the "bell-metal" ore more than the ordinary copper ore. The Society could not but feel great pleasure in receiving these communications from Mr. Reynolds.

Mr. Scott hoped that the present communication might be only the prelude to future investigations of its author on the same subject, as Mr. Reynolds was one of the few chemists in Ireland who were carrying on experiments with the spectrascope.

The Chairman then called on Professor Haughton to read his "Note on the Occurrence of Exogenous Wood in the Lower Carboniferous Limestone of the county of Mayo" (p. 122).

Dr. John Barker exhibited a microscopic section of the specimen referred to by the Rev. Professor Haughton.

Mr. Scott, one of the Honorary Secretaries, read a paper by Dr. T. Sterry Hunt, of the Geological Survey of Canada, "On the Chemical and Mineralogical Relations of Igneous Rocks" (p. 85).

The Chairman remarked that Dr. Hunt's paper was one of the most important and comprehensive ones that he had ever heard read before any society. It contained the results of years of reading and research, and it appeared to him that it was of such a character that it would be necessary to read it carefully when it was printed, before any one could venture to offer an opinion on the conclusions arrived at in it. He would only say that he congratulated himself and the Survey on this paper having been brought before the Society, before the Geological Survey attacked the primary and the metamorphic rocks of Connaught and Ulster.

Professor Haughton said that, as Dr. Hunt was not a member of the Society, it was necessary to move that the paper be referred to the Council for publication; and, in doing so, he could not fully express the pleasure which he felt in hearing such a paper as that which had just been read. He agreed with the Chairman that it was rather too hard a nut to crack on first hearing. He had, however, been able to catch one or two statements in the paper, from which it appeared that Dr. Hunt was inclined to return to the views of Werner on metamorphism, referring this action mainly to aqueous agency, to which action he would also refer the filling of lodes. He was, however, hardly inclined to agree with Dr. Hunt that the presence of sulphur and of phosphorus in a free state were due to aqueous agency and reduction by means of the decomposition of vegetable matter. As regards carbon, he was disposed to admit the conclusions of Dr. Hunt, as that element required the agency of organic life to separate it from its compounds with oxygen. Phosphorus did not occur in a free state in the earth, as it was very liable to oxidation, and therefore was found combined with oxygen. However, it occurred in meteoric stones; and from a conversation which he had held with Dr. Hunt last autumn, he found that he was disposed to carry his views to their legitimate conclusion, and attribute not only the sulphur and phosphorus, but also the native metals found in meteorites, to aqueous and organic agency. This view certainly received confirmation from the discovery, by Delesse, of the presence of volatile hydro-carbons in meteoric stones, which proved that they could not be simply igneous products.

Captain Meadows Taylor seconded the motion, which was passed unanimously, and the meeting was adjourned.

General Meeting, May 13, 1863.

The President in the Chair.

The Minutes of last meeting were read, compared, and signed, donations announced, and thanks voted.

Mr. Charles Ensor, Jun., of No. 4, North George's-place, was elected an Associate Member.

The Secretary, Mr. R. H. Scott, read a communication from Dr. T. S. Hunt, containing some additions to his paper on "The Chemical and Mineralogical Constitution of Igneous Rocks," read at the last meeting.

Mr. Scott said the Society owed a very greatd ebt of gratitude to Dr. Hunt for having selected them as the medium of communicating his paper to the scientific societies on this side of the Atlantic; and therefore he had very great pleasure in moving that this communication be printed in the Society's "Journal," as an addition to the original paper.

The Rev. Professor Haughton seconded the motion. It appeared to him that the absence of lime in the feldspars of Ireland was the great characteristic which distinguished them from the feldspars of the Labrador series.

The motion was put and carried.

The Rev. Maxwell Close read a paper "On some Striated Surfaces in the Granite near Dublin" (p. 96).

The Rev. Professor Haughton said the paper of Mr. Close exhibited a great deal of laborious research on a very important subject, and constituted a most interesting addition to their knowledge.

The President made some observations on the subject of the paper; and he considered that the polish observed by Mr. Close on some of the slickenside surfaces could not have been produced by motion in one direction, as it required a varied direction of motion to produce a polish.

Dr. Carte read a paper on "The Varieties of Reindeer which have been found Fossil in Ireland" (p. 103).

The President said it was advisable not to proceed to a discussion until they first heard Dr. Haughton's communication on a kindred subject.

The Rev. Professor Haughton said he would only on that occasion announce the very interesting fact that a nearly perfect skeleton of the fossil Red Deer had been found in the county of Fermanagh. He hoped at a future meeting of the Society—probably in November next—to lay the skeleton before the Society for the inspection of the members. It was a fact common to both the fossil Reindeer and to the fossil Red Deer, the discovery of which he now announced, that although skulls and horns of these animals had been frequently found, the remaining bones of the skeleton were exceedingly rare. The portions of the skeleton found at Dungarvan consisted of the cannon bone of the hind leg and of a portion of the cranium. He took these to London, and examined them with the aid of Mr. Waterhouse, of the British Museum; and the conclusion at which they both arrived was, that they belonged to the Arctic variety of the Reindeer. With the single exception of the bone of the hind foot, which was now produced, he did not think there had been a single bone of Reindeer discovered in Ireland, except the fossil skulls and antlers which had been mentioned. This had been likewise the case hitherto with respect to the Red Deer until the skeleton, the discovery of which he now announced, had been found within the last two months by a farmer in a bog. The skeleton was nearly perfect, with the exception of a few small bones of the feet; and he had great hopes that it would arrive in Dublin safely. With respect to the question, how these fossils came to the place where they were found, he believed that the animals all died at those places; and he thought it probable that the skulls were fixed by the horns, whilst the other bones were washed away. The problem, however, was a difficult one to solve. One of the fossils on the table presented a skull with lower jaw perfect, besides antlers. Professor Haughton stated some reasons for thinking that the existing Reindeer belonged to an older epoch than the *Megaceros Hibernicus*; and observed that he thought the supposition of "drift" quite unavailing to explain the presence of the fossils in question in these countries. The animals were all subsequent to the "drift." There seemed to be no doubt that the Arctic variety of Reindeer lived in Ireland long after it became extinct in more eastern parts of Europe.

Dr. Carte stated that the fossils that came from Limerick were found along with fossils of the Megaceros, and upwards of twenty skeletons of the Megaceros had also been found associated with the Reindeer fossils that were discovered at Kilternan, county of Dublin; so that, if the animals were not absolutely identical in date, they must have existed at periods very close to each other. He was inclined to think that the reason why the other bones of the Reindeer besides those of the head were not met with was, that they were not supposed by the persons who usually found them to be of any value, and were, consequently, not preserved.

Mr. Baily said he had seen Reindeer fossils in England, found associated with Elephants' teeth.

The Society then adjourned.

General Meeting, June 10, 1863.

The Rev. Professor Haughton in the Chair.

The Minutes of last meeting were read and confirmed, donations were announced, and thanks voted.

Mr. R. H. Scott read a paper on "The Fossils of the Yellow Sandstone of Mountcharles, county of Donegal" (p. 107).

The Chairman said the paper of Mr. Scott was valuable, as showing the correlation of the lower Carboniferous beds of the north and south of Ireland. The shells and the fish remains found in the sandstone to which he referred, established a striking analogy between it and the limestone beds of the opposite coast of Mayo.

Professor Jukes said that it was very interesting to see that undoubted Carboniferous fossils had been discovered in the sandstone of Donegal; but he was disposed to think that the Donegal beds were higher in the series than the Coomhola grits, as the fossils peculiar to that formation did not appear to be found in Donegal, with one or two exceptions.

Mr. Baily remarked that the fossils exhibited were, in his opinion, apparently undoubted Carboniferous forms, with the exception of one of the bivalves, *Cucullæa Griffithii* of Mr. Salter, which appeared to be identical with a species from the Coomhola grits. The other remains found by Mr. Scott, although indistinct, appeared to be undoubtedly fish remains, and were, perhaps, scales of Holoptychius. The plant from Inver, mentioned by Mr. Scott as perhaps new, seemed to him to be identical with one called *Sagenaria Weltheimiana*, which was found at Tallow-bridge, county of Waterford. As regarded the age of these rocks, he would remind the meeting that Mr. Davidson, the highest authority on the subject, considered that in Ireland we had no evidence of the presence of true Old Red Sandstone, as the Brachiopoda in M'Coy's Synopsis were found also in the Carboniferous system; so that, with the exception of the Kiltorcan beds, sandstones in Ireland are to be referred to the Carboniferous epoch.

The Chairman said that it would not be right to let that opportunity pass of saying that they were greatly indebted to Mr. Harte, the County Surveyor of Donegal, who had lately become a member of the Society, and to whose indefatigable zeal they owed a large number of the specimens exhibited on that occasion.

The chair was then taken by Professor Jukes, while

The Rev. Dr. Haughton read his paper "on Primary and Secondary Joints, and their Mechanical Origin," in which he showed how the various systems of joints which are observed in rocks might be produced by pressures acting in certain directions on the masses of rock which form the district.

The Chairman said it was a great advantage to the Society to have as one of its members a man possessed of so varied attainments as Professor Haughton, whose extended knowledge enabled him to approach difficult questions in the science which they cultivated from aspects quite unanticipated by other members. He was himself inclined to attribute the formation of primary joints to the contraction or consolidation of the original rocks in which they occurred.

The meeting then adjourned.

General Meeting, November 11, 1863.

The President in the Chair.

The Minutes of the last meeting were read, compared, and signed, donations announced, and thanks voted.

The following gentlemen were elected members:—R. P. Williams, Esq., Dame-street; A. Macalister, Esq., 10, Gardiner's-place; and M. H. Ormsby, Esq., 16, Fitzwilliam-square; and Messrs. C. Ensor, G. F. Harman, James Brancker, T. Freeman, and R. C. Woodward, were elected Associates for the present session.

In pursuance of a recommendation of the Council, Dr. T. Sterry Hunt, F. R. S., of Montreal, was elected an Honorary Member.

The Secretary read a short paper by Mr. G. H. Kinahan, of the Geological Survey, "On Crumpled Lamination in Shales" (p. 113).

The Secretary next read another paper by Mr. Kinahan, "On the Eskers of the Central Plain of Ireland" (p. 109).

The Rev. Professor Haughton said that some of the views brought forward in the paper seemed to him to agree with the opinions as to the origin of eskers put forward some years ago by the late Professor Kinahan, brother of the author, in a paper which he read on the drift of Bohernabreena, an abstract of which was published in Vol. viii. of the "Journal." The paper at present read showed the great care with which Mr. G. Kinahan had investigated the subject.

Professor Haughton read his "Observations on the Fossil Red Deer of Ireland, founded on the Skeletons found at Bohoe in the county of Fermanagh, in 1863" (p. 125).

Dr. E. H. Bennett remarked that the different distribution of the vertebræ in the recent and fossil animals did not appear to him a matter of much importance, as similar variations have been observed in all the higher animals, not excluding man. He considered the two jaws, recent and fossil, though different in size, to belong to animals of the same species.

Dr. Macalister remarked that, among other points, the much greater size of the anterior dental foramen in the fossil specimen, compared with the recent one, seemed to him to show some difference between the jaws under consideration.

The Rev. Mr. Close reminded the meeting that the experiments of Mr. Darwin had proved that the entire number of the vertebræ might be varied in the case of the pigeon.

Dr. Bennett observed that it was well known that confinement exerted a greater influence on the Cervidæ than in other animals, and that the small size of the recent jaw might be thus explained, as the Red Deer to which it had belonged had lived and died in the Zoological Gardens.

Professor Haughton wished to point out some points which had struck him as being very remarkable, and which were clearly to be seen in a photograph of the skeleton in Trinity College Museum, which he exhibited. These were the peculiar processes on the second and sixth cervical vertebræ, the latter of which were to be remarked in all the deer which had large antlers. The apparent object of the large size of these processes was, as points of attachment of muscles, to counteract the momentum of the heavy horns when the animal turned his head.

Mr. Ormsby read his paper "On a Steatitic Mineral from Ballycorus" (p. 120), which he found to be an altered feldspar, similar to that from the same locality which was analyzed by Mr. England, and published by Professor Haughton, in Vol. vi. of the "Journal."

The meeting then adjourned.

GENERAL MEETING, DEC. 9, 1863.

THE REV. S. HAUGHTON, M. D., in the Chair.

The Minutes of last meeting were read, compared, and signed, donations announced, and thanks voted.

The Rev. R. Crook, LL. D., was elected a member of the Society, and the following gentlemen Associates for the session, 1863-4:—W. Watson, Esq.; P. M. Mullens, Esq.; H. Russell, Esq.; R. Stein, Esq.; H. B. S. Montgomery, Esq.

Mr. Jukes read his paper on "Some Indentations in Bones of the *Cervus megaceros*" (p. 136).

The Chairman said he was sure the meeting would concur with him in expressing their thanks to Mr. Jukes, for the manner in which he had introduced this most interesting subject. In order to have all the evidence before taking the discussion, he would call on Dr. Lentaigne, who, according to the announcement in the paper of the evening's business, was to exhibit "Bones of the *Cervus megaceros*," with similar indentations to those in the bones described by Mr. Jukes, to make whatever remarks he wished with respect to the bones exhibited by him.

Dr. Lentaigne said that the bones which he had placed on the table were given to him by the late Mr. Richard Glennon, who was under a very strong impression that the *Cervus megaceros* was contemporaneous with man. Mr. Glennon's impression was, that the female of that creature used to be milked as cows are. Mr. Glennon believed that the bones were usually found in abundance in localities which had been formerly occupied by ancient human habitations, and these bones were very frequently bones of female animals. It was, in his opinion, quite impossible that the indentations in the bones which he produced could have been made by anything save the cut of a sharp instrument, such as a hatchet or stone. There was also an appearance of something like granulations, which looked as if the injuries had been inflicted during the life of the animal, and that there was an effort of nature to recover from the effect of them. Mr. Glennon told him of a skull of an animal of this kind in which a celt was found, but he never saw it. He had in his own possession a very large skeleton, on the horns of which was something very like carving; and Mr. Glennon was always of opinion that it was the skeleton of an animal which had been a pet. He did not know where the bones at present exhibited had been found.

The Chairman said that, since the progamme had been printed, Dr. Barker had placed at their disposal some Megaceros bones which were preserved in the College of Surgeons.

Dr. Barker said he had very little to say about these bones. They had been picked out from the skeletons of five animals which were in the museum of the College. Marks would be found in them similar to those described by Mr. Jukes. These marks or grooves were principally in the longer bones, and some were highly polished, as if the indentation had been caused by the friction of a substance lying for a length of time along with the bone. The indentations were generally in an oblique direction. Upon one rib there was a curious double cut, like that on one of Dr. Lentaigne's specimens. From the remains of the five animals he had collected more than a dozen bones having some of these indentations, some of which were highly polished. He saw no evidence of granulation in the bones which he exhibited. That would scarcely be expected to occur in bones beneath the periosteum. In two of the bones were marks or cuts, which he thought were recent. With respect to the other indentations, he agreed with Mr. Jukes that they were the result of pressure or friction, and not of injuries inflicted by man.

The Chairman said that, before inviting discussion, he would add to the evidence already before them that afforded by the skeletons in the Museum of Trinity College. It was impossible to place these remains before the view of the meeting; but Dr. Hart, and other careful observers from the earliest times, had noticed what they considered to be artificial marks or cuts on bones of the Megaceros Deer. Some of the specimens referred to in Dr. Hart's memoir were preserved upstairs, containing very well marked examples of these rubbings, or polishings, or whatever they were. They occurred in bones from almost every part of the skeletons of these remains, including the cannon, the tibia, and the long bones in general. The question which they were now called on to discuss was, whether these marks were the result of natural or artificial causes. For his own part, he would much rather be in the body of the room than occupy the chair on that occasion, because the office of the Chairman forced him to be impartial. However, he must hold the balance fairly; but, as he was not to be a combatant, he hoped there would be combatants; and he begged that gentlemen, even though they were not members of the Society, would express their opinions freely. He would express no opinion of his own; but he invited the opinions of those present upon the question as he had limited it.

Dr. Bennett asked for a definition of what the President meant by "natural or artificial."

Chairman—Done by man, or by some physical cause.

Dr. Bennett—Pathological causes before the death of the animal might have produced such marks.

The Chairman said that that question was quite open too.

Dr. Wilde said it was not the first time he had heard the question discussed there as to whether the *Cervus megaceros* and its animal contemporaries were contemporaneous with the human race in this island, or not, and hoped it would not be the last. He was

under the disadvantage of never having seen these bones until now, and he regretted not having had an opportunity of looking at them with a glass by daylight. Looking at those bones produced by Mr. Jukes, he found that one of them had a remarkable gap cut out in it, and polished in the highest manner. Another had two indentations, which were evidently produced either by a saw or knife. Then there were two bones indented to each other, and fitting together. He saw no reason why the indentations in these last should not have been produced by man, and the bones strapped together so as to make a weapon. There were other cuts, or indentations, which might have been produced by ligatures or by pressure. He thought the marks on these bones afforded evidence of several different modes of action. Even if some of the indentations were made by man, that would not prove that man and the living animals were contemporaneous. He looked on some of the indentations as decidedly artificial, and as having been produced after the animal was dead.

Dr. Frazer thought some of the indentations might have been produced by absorption of the bone under certain circumstances. A vertical section of the bone near the cut might throw light on that point.

Dr. Bennett said that in two of the bones produced the indentation was evidently caused by the friction of one of them against the other. He did not think any of the changes occurred until after the death of the animals. The changes were, he thought, subsequent to the removal of the soft parts; and he could see no evidence of any pathological change connected with the bones. The indentations must, he thought, be attributed to either the hand of man, or to friction caused by pressure on the slow movements of the bones.

Dr. Carte said he had made an experiment upon one of the bones—the tibia of a Megaceros. He had rubbed it with a rib of the same animal and with emery powder, and had in that way produced an indentation very similar to those in question found in the bones when disinterred. That showed that the friction of two bones with sand between them might have produced such marks.

M. Ross, of the Hudson's Bay Company Service, said he had seen offensive weapons used by North American Indians, which were formed by the joining of two bones exactly in the way in which two of the bones on the table appeared to be indented together. He had observed driftwood in the lakes which was cut very much in the way these bones were indented. He knew an instance of a Moose Deer which was trained to go in harness like a horse.

M. Gages said that, in his opinion, no possible amount of simple pressure would produce a solution of continuity such as they saw in the specimens before them. The action of a chemical solvent would affect the whole bone, and could never leave a clean cut. In his opinion, the marks were undoubtedly artificial; and his friend Mr. John Kelly, who was so well known in this Society, had remarked to him that in his youth he had often seen two bones just like the tibia and the piece of the antler shown by Mr. Jukes tied together, and used as a whiteboy's cross. M. Gages then tied the bones together with his handkerchief and exhibited them to the meeting, and they formed a very well-shaped cross.

Mr. Baily thought the indentations had been made by some instrument. In the condyles of one of the bones there were holes, which looked as if they had been hung up. The stains appearing on some of them might have been caused by the roots of water plants.

Dr. Petrie said he wished to mention that in the "Gentleman's Magazine" for December, 1859, there appeared a notice of a paper read at the Yorkshire Philosophical Society by a Mr. Denny, which was considered conclusive as to the fact of the animals in question having lived contemporaneously with man.

Mr. Jukes, in reply, said that he had shown these bones to every one whom he could get to come to look at them. He mentioned them to Dr. Wilde some weeks ago, and begged of him to come and see them. They had also been exhibited in a case in the Museum of Irish Industry, with a special note attached to them; and if gentlemen would only take the trouble to walk through that gallery, they might see things worthy of their attention. With regard to the discussion which had taken place, not a single thing had been said which he had not either anticipated himself or had already heard

objected by others, and had not put into his paper. M. Gages and he had had several private battles about what M. Gages called a "solution of continuity" in the bones; and the point was, could any natural action produce it? He brought these bones to the last meeting of the British Association; and a grand discussion took place on them there, at which he heard various opinions expressed. Dr. Falconer was strongly in favour of the idea that the marks were produced by some sharp instrument. Dr. Falconer mentioned, from his knowledge of the habits of savage tribes, that after they stripped a bone of a deer of the flesh they gave it a cut at the point where the tendons are attached in order to remove them; and consequently he was of opinion that the old "pleistocene" men, who existed long anterior to tradition or history, may have similarly used the bones now under discussion. That the bones of the *Cervus megaceros* were constantly found associated with those of other animals now extinct was a palæontological fact beyond question. The marks in question were important, as affording a clue to the date of the extinction of the Cervus. There was not the slightest doubt that man had lived, in other countries, contemporaneously with the Mammoth, the Woolly Elephant, the Woolly Rhinoceros, the Cave Lion, the Cave Bear, and other extinct animals; but the point was, did he exist in Ireland when those animals lived here? Had pleistocene man reached Ireland then?—was this island separated from, or joined to, England then, and could he have crossed? If these indentations did not prove the contemporaneity of man with the animals, nothing else of a similar kind could; but he inclined to the opinion that no such marks on bones could prove human agency.

The Chairman said they could not promise an immediate re-discussion of this question to Dr. Wilde; but, no doubt, it would turn up again and againin the course of their future proceedings. Before they separated, he wished to call attention to the last announcement in the paper, which related to a discovery fully as important as the question as to how the indentations in the bones of the *Cervus megaceros* had been made. The fact to which he alluded was the subject of a paper by Dr. Carte, which was to have been read that evening, and was of a positive and definite character, being the recent discovery of the remains of the Polar Bear for the first time in the British Islands, in the celebrated locality of Lough Gur, in the county of Limerick. This was an exceedingly important and remarkable event; and, though the author of the discovery was present, he must say that it reflected great credit upon his skill and ability as a comparative anatomist. On the evening of the second Wednesday in January that question would come before them, to which evening they now adjourned.

General Meeting, January 13, 1864.

J. Beete Jukes, Esq., F. R. S., in the Chair.

The Minutes of last meeting were read, compared, and signed, donations announced, and thanks voted.

G. Dixon, Esq., 10, Burlington-road, and W. H. Stackpoole Westropp, Esq., 2, Idrone-terrace, Blackrock, were elected members of the Society.

The Rev. Professor Haughton read his paper, entitled "An attempt to calculate the Duration of Time involved in Geological Epochs." He said that as geologists of modern times had got into the habit of speaking of long periods of time with an extreme vagueness of idea as to what their words meant, he thought that it would be a point of interest to consider for how long a space of time animals could have existed on the globe. If we admit, as most scientific men are prepared to do, that the earth has cooled down from a gaseous condition to its present solid consistence, it is evident that organic beings could not have existed on the earth until it assumed some degree of solidity. He would take the results of trustworthy scientific experiments and calculations as a basis, and lay the results of his calculations before the meeting. Most of the members present were acquainted with the ingenious proof, which we owe to Arago, that the earth has not cooled half a degree (Fahrenheit) since the time of Joseph. His proof is founded on the fact of Joseph's having received from Jacob, in the present sent to him to Egypt, some fruit, which still grows in Palestine, and which will not bear a climate differing in any way

from that of Palestine at the present day. Hence we see that the earth is only losing heat very slowly now. Professor Bischoff, of Bonn, had made some experiments on the rate of cooling of basalt; and on these Professor Helmholtz had founded a calculation, by means of which he proved that the period which a globe of basalt of the size of the earth would take take to cool from 2000 deg. C. to 200 deg. C. would be 350,000,000 of years. This calculation he would assume; and as the extreme limits of temperature to which his reasoning would apply, he would take 122 deg. F. and 77 deg. F. 122 deg. F. is the temperature at which albumen coagulates, and therefore no animal could live at that temperature, as its blood would be coagulated. It was true that enthusiastic votaries of the Turkish bath would say that existence was possible at much higher temperatures, but they would find few to believe them. As the lower limit, he would take the temperature of 77 deg. F., which had been admitted to have been the probable temperature of these islands at the time of deposition of the London clay. That this was not a random assumption was proved by the fact that Professor Heer, of Zurich, had lately expressed his opinion that the temperature of Switzerland during the miocene epoch was between 67 deg. and 72 deg. and this period is subsequent to the London clay. Assuming, then, these limits, and the period above named (350,000,000 of years) as his data, he found that the earth, if it be supposed to be made of basalt, would require 1,280,000,000 of years to cool through the required amount. This reasoning was based on the well-known law of cooling of a heated body; and it was obvious to every one that the second period must be much longer than the first one, as the hotter a body is, the faster it will cool. In this period we have space enough for the wildest phantasies of geologists, as no person in the room could form any idea of the difference between 1,279,000,000 and 1,280,000,000 of years. Dr. Haughton concluded by saying that he did not conceive that changes of climate, produced by alteration in the relative positions of land and water, could account for the facts discovered by Sir L. M'Clintock about the fossils of the Arctic regions. Nor did he now believe (though he at one time had believed, and now wished to read his recantation) that the axis of the earth had changed its position.

The Chairman expressed his own sense of the great value of Professor Haughton's paper, and its exceeding ingenuity in giving a solid basis for that superstructure of imagination in which geologists, according to the author's account, were prone to indulge. He had given them sufficient scope for their theories in the definite period of millions of years, a space of time which it was simply impossible for any geologist to grasp. He had, however, gone over so many subjects, that they could not discuss the whole question that evening, especially as another valuable paper was to come before them. The discussion, therefore, should be strictly limited to the question of the calculation, from certain actual data, of the period that elapsed from the time when the temperature of the globe was 122 deg.—assumed by Dr. Haughton as the maximum at which animal life was possible—until it had cooled down to 77 degs. He would not limit them as to the geological dates which they should give to those extremes of temperature.

Mr. E. Blyth, late of Calcutta, remarked that the multiplicity of bearings of the subject upon which Professor Haughton had treated would occupy about a week to consider fairly. He would, therefore, confine himself as far as possible to the special question before the meeting, in conformity and accordance with the judicious request of the Chairman. It had been well remarked and reiterated, that it was beyond the powers of the human mind to comprehend or adequately appreciate the idea of millions of millions, or trillions; but, fortunately, there was no necessity for such strains upon the imagination, as so much depended on the magnitude of the unit assumed as a starting point. The more we reflected upon the ideas of space and time, the more analogous they became, and the more capable of reciprocal illustration. In reviewing the epochs of past time, he held that it was impossible to compute or fix the limit of duration of any particular period, because the causes in operation might be more or less active during an indefinite succession of ages, when any especial deposit was in process of formation. The utmost that could be attempted (unless, perhaps, in rare and exceptional cases) was, at most, merely a vague approximation; and this, in the opinion of the speaker, could best be rendered intelligible by the comparison of the distances of time with those of space—even as those of space have been illustrated and rendered more comprehensible by the measurement of time. Thus, a ray of light traverses the distance of ninety-three

millions of miles, from the sun to this planet, in about eight minutes and a-half. It took, say, three thousand years, to reach us from the nearest known fixed star (so called), as determined by parallax, which is Alpha Centauri; and at least thirty thousand years for a ray of light to reach us from the grand nebula in the belt of Orion. Suppose we compare the distance in past time of the termination of the glacial era of the northern hemisphere to the distance in space of the earth from the sun, we may, in like manner, compare the distance in space from this planet to the star Alpha Centauri to, say, the period of the deposition of the earlier tertiaries, rather than to that of the cretaceous period; that of Orion to that of the coal measures; and that of the distant nebulæ resolved by Lord Rosse's telescope, to that of such early forms of life as the Oldhamia. Mr. Blyth merely threw out the idea, which he admitted to be as vaguely approximative as any other possible mode of computation.

Dr. Carte then read his paper "On the recent Discovery of Bones of the Polar Bear in Lough Gur, county of Limerick; with Observations on their Comparison with Bones of the Cave Bear, in the Collection of the Earl of Enniskillen" (p. 114).

The Chairman said they were all indebted to Dr. Carte for the paper which he had submitted, and also for the very clear manner in which he demonstrated the bones which he had laid before them; and he thought that every one present must be of opinion that Dr. Carte had made out his case. The occurrence of the remains of the Polar Bear in the British Islands was, he believed, a new fact, now asserted for the first time, and it was a most important one. It clenched a great quantity of evidence; and it met the objection which might otherwise have been raised to the existence in this island at a former era of a glacial period, founded on the allegation that, although they had remains of the Mammoth, of the Woolly Elephant and Rhinoceros, and of the Reindeer, they had no sign of the Polar Bear. As to the question of time, if the climate here were at all like that in the same latitude on the other side of the Atlantic, there would be no difficulty in accounting for visits of the Polar Bear to this country. He could say, from his own personal experience, that when he was in Newfoundland he was continually hearing of the Polar Bear in latitudes a good deal south of ours. The whole of Newfoundland lay south of Ireland, and hardly a winter passed in the former island in which the Polar Bear did not land upon it from the great sheets of ice that connected the island either completely, or with only a narrow neck of water intervening, with the mainland. Seals came upon the ice, and the Bears followed them. He had been with a sealing party who had killed 4300 seals, but was not lucky enough to meet a Bear; but he did hear of a Seal-hunter being killed by a Polar Bear at no very great distance from the coast of Newfoundland, and in about the latitude of Dublin. He had not the slightest doubt that the Polar Bear whose remains were exhibited lived in this country contemporaneously with the *Cervus megaceros*, the Mammoth, the Reindeer, and the other animals of the glacial period—a period far older than that of any archæological record. It was curious that they found these remains at the bottom of Lough Gur, with several articles of human manufacture; but he did not believe that the finding of all these articles in the same lake proved that they had been deposited at the same time there, and it did not shake his conviction that the period of the existence of the Polar bear in Ireland was long anterior to that of man. The human bones might have been those of men drowned there at a recent time. Man might have, and probably did, exist in other countries at the epoch referred to, but not in Ireland.

Dr. Blyth remarked that he had carefully examined the bones, and that he was fully convinced of the accuracy of Dr. Carte's determination of them, even though somewhat sceptically disposed at first. This was, however, unreasonable, as all the forms of arctic Mammalia were successively turning up in the superficial deposits of what is now the temperate zone of the Northern hemisphere. The most remarkable instance of all was the occurrence of unmistakeable remains of the *Ovibos moschatus*, or Musk Ox, in Devonshire and elsewhere; for this creature is now geographically confined to the arctic barren grounds of America, which quite resembled the "tundras" of Arctic Siberia, and the mountain region of Lapland, so eloquently and even pathetically described by the great Linnæus. As for the alleged (extinct) second species of Musk Ox, the Siberian *Ovibos Pallantis* of the late Professor de Blainville, that was now properly classified as

one of the two species of Bootherium, an extinct boreal genus, intermediate between Ovibos and Bison.

The Rev. Dr. Haughton said he wished to congratulate the meeting upon two things. The first was that their humble Society had been the means of communicating a new and important fact to the world; the second was, that Dr. Carte's decision as to these bones had been confirmed by so distinguished an authority as Dr. Blyth. He did not himself believe that Dr. Carte's authority required any confirmation; but as that belief might not have been shared in by others, it was a matter of no small gratification to have his authority borne out by that of so distinguished an observer. With regard to the bones laid before them, he would make one or two observations. In the first place, he had been struck by a remarkable similarity, in point of condition of preservation, between the bones of the Bear and the human bones associated with them; and he had no hesitation in saying that they could not have been severally deposited at periods widely asunder from each other. He preferred to believe that the man and the bear lived at the same time. He would admit that the padlock found with them was probably only about twenty years old. Lough Gur was a very remarkable place, in consequence of its richness in these bones. What brought all these things there, a collection which included bones of every description, bones of the Megaceros, the Wolf, the Irish Wolf-dog (he believed Lord Dunraven had got a specimen of it), the Fox, the great Irish Red Deer, and now the Polar Bear? He had heard it stated by well-informed persons that there was reason to believe that the lakes of the King's County and of Meath were formerly used as hunting lakes, into which animals were driven by dogs. Might this also have been the case with Lough Gur? For his part, he believed that the ancient Irish killed and ate the Megaceros.

Mr. Scott said that two distinct kinds of human remains had been found in Lough Gur. One of these was evidently very ancient. There was a skull, however, which did not appear to have been very long in the lake. He would ask anatomists to say whether some of the skulls found in the lake did not point to the existence in this country at a remote period of a race totally distinct from present inhabitants?

Dr. Blyth said there was not sufficient of the skull remaining to warrant an opinion being formed.

The meeting then adjourned to the second Wednesday in February.

Anniversary Meeting, Feb. 10, 1864.

The Anniversary Meeting of the Society was held on the 10th of February, in the New Buildings, Trinity College, at half-past eight o'clock.

The Rev. H. Lloyd, D. D., President, in the Chair.

The Ballot for the election of Members of Council and Honorary Officers was declared open.

The Minutes of meeting were read, compared, and signed, donations announced, and thanks voted.

G. A. Waller, Esq., James' gate, and Thomas Kinahan, Esq., Sandycove, were elected members of the Society.

Mr. Scott read the Annual Report (p. 137).

The ballot was declared closed; Mr. Sanders and Mr. Reeves were appointed scrutineers, and the Officers and Council (p. 153), were found to be duly elected.

The meeting was then adjourned until the second Wednesday in March.

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